MTTL

INTEGRATED CIRCUITS
MC500/MC400 SERIES

MTTL

INTEGRATED CIRCUITS

INDEX

DEVICE SPECIFICATIONS

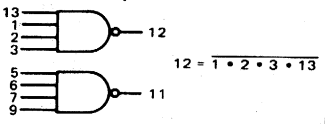
NUMERICAL INDEX
(Functions and Characteristics)

V_{CC} = 5.0 V, T_A = 25°C

Function	Type		Output Loading Factor Each Output		Propagation Delay t_{pd} ns typ	Power Dissipation mW typ/pkg	Page No.
	Case 609, 93 0 to +75°C	Case 609 −55 to +125°C	MC400 Series	MC500 Series			
Dual 4-Input NAND Gate	MC400 MC450	MC500 MC550	12 6	15 7	10	30	4-14
Expandable 4-Wide 2-2-2-3-Input AND-OR-INVERT Gate	MC401 MC451	MC501 MC551	12 6	15 7	12	30	4-24
Single 8-Input NAND Gate	MC402 MC452	MC502 MC552	12 6	15 7	12	15	4-10
2-Wide 3-Input AND-OR-INVERT Gate with Gated Complement	MC403 MC453	MC503 MC553	12 6	15 7	11	35	4-27
Expandable 3-Wide 3-Input AND-OR-INVERT Gate	MC404 MC454	MC504 MC554	12 6	15 7	12	25	4-20
Expandable 2-Wide 4-Input AND-OR-INVERT Gate	MC405 MC455	MC505 MC555	12 6	15 7	12	20	4-16
Expandable 8-Input NAND Gate	MC406 MC456	MC506 MC556	12 6	15 7	18	15	4-12
Line Driver	MC407 MC457	MC507 MC557	12 6	15 7	25 @ 1000 pF Load	60	4-50
Quad 2-Input NAND Gate	MC408 MC458	MC508 MC558	12 6	15 7	10	60	4-22
4-Wide 3-2-2-3 Input Expander for AND-OR-INVERT Gates	MC409 MC459	MC509 MC559	12 6	15 7	–	–	4-48
Dual 4-Input Expander for AND-OR-INVERT Gates	MC410 MC460	MC510 MC560	12 6	15 7	–	–	4-46
Dual 4-Input Expander for NAND Gates	MC411 MC461	MC511 MC561	12 6	15 7	–	–	4-44
Triple 3-Input NAND Gate	MC412 MC462	MC512 MC562	12 6	15 7	10	45	4-18
R-S Flip-Flop	MC413 MC463	MC513 MC563	12 6	15 7	f = 20 MHz	30	4-42
AND J-K Flip-Flop	MC415 MC465	MC515 MC565	12 6	15 7	f = 20 MHz	40	4-32
OR J-K Flip-Flop	MC416 MC466	MC516 MC566	12 6	15 7	f = 20 MHz	50	4-37
Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate	MC420 MC470	MC520 MC570	12 6	15 7	12	40	4-30

GATES

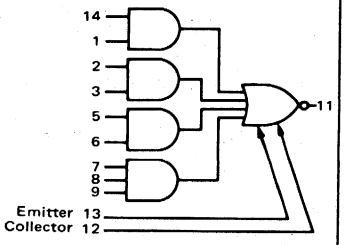
MC400/MC450
MC500/MC550
Dual 4-Input NAND Gate



$12 = \overline{1 \cdot 2 \cdot 3 \cdot 13}$

t_{pd} = 10 ns typ
P_D = 30 mW typ/pkg

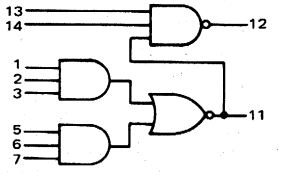
MC401/MC451
MC501/MC551
Expandable 4-Wide 2-2-2-3 Input AND-OR-INVERT Gate



$11 = \overline{(14 \cdot 1) + (2 \cdot 3) + (5 \cdot 6) + (7 \cdot 8 \cdot 9) + \ldots}$

t_{pd} = 12 ns typ
P_D = 30 mW typ/pkg

MC403/MC453
MC503/MC553
2-Wide 3-Input AND-OR-INVERT Gate with Gated Complement

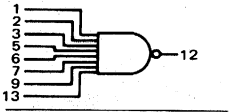


$12 = \overline{11 \cdot 13 \cdot 14}$

$11 = (1 \cdot 2 \cdot 3) + (5 \cdot 6 \cdot 7)$

t_{pd} = 11 ns typ
P_D = 35 mW typ/pkg

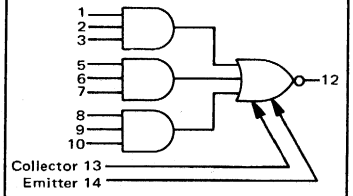
MC402/MC452
MC502/MC552
Single 8-Input NAND Gate



$12 = \overline{1 \cdot 2 \cdot 3 \cdot 5 \cdot 6 \cdot 7 \cdot 9 \cdot 13}$

t_{pd} = 12 ns typ
P_D = 15 mW typ/pkg

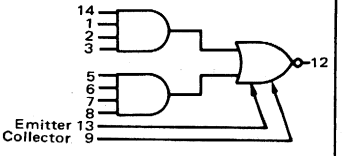
MC404/MC454
MC504/MC554
Expandable 3-Wide 3-Input AND-OR-INVERT Gate



$12 = \overline{(1 \cdot 2 \cdot 3) + (5 \cdot 6 \cdot 7) + (8 \cdot 9 \cdot 11) + \ldots}$

t_{pd} = 12 ns typ
P_D = 25 mW typ/pkg

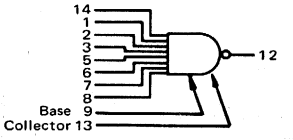
MC405/MC455
MC505/MC555
Expandable 2-Wide 4-Input AND-OR-INVERT Gate



$12 = \overline{(14 \cdot 1 \cdot 2 \cdot 3) + (5 \cdot 6 \cdot 7 \cdot 8) + \ldots}$

t_{pd} = 12 ns typ
P_D = 20 mW typ/pkg

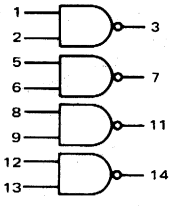
MC406/MC456
MC506/MC556
Expandable 8-Input NAND Gate



$12 = \overline{1 \cdot 3 \cdot 5 \cdot 7 \cdot 8 \cdot 14 \cdot \ldots}$

t_{pd} = 18 ns typ
P_D = 15 mW typ/pkg

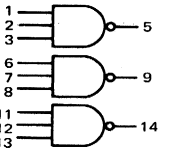
MC408/MC458
MC508/MC558
Quad 2-Input NAND Gate



$3 = \overline{1 \cdot 2}$

t_{pd} = 10 ns typ
P_D = 60 mW typ/pkg

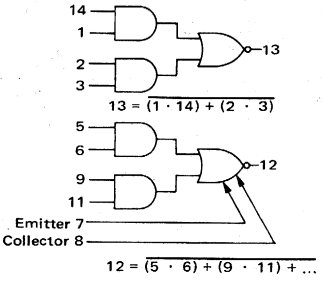
MC412/MC462
MC512/MC562
Triple 3-Input NAND Gate



$5 = \overline{1 \cdot 2 \cdot 3}$

t_{pd} = 10 ns typ
P_D = 45 mW typ/pkg

MC420/MC470
MC520/MC570
Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate



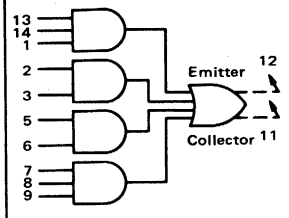
$12 = \overline{(5 \cdot 6) + (9 \cdot 11) + \ldots}$

t_{pd} = 12 ns typ
P_D = 40 mW typ/pkg

EXPANDERS

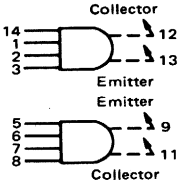
MC409/MC459 MC509/MC559

4-Wide 3-2-2-3 Input Expander for AND-OR-INVERT Gates



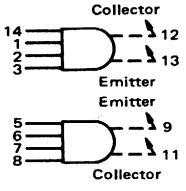
MC410/MC460 MC510/MC560

Dual 4-Input Expander for AND-OR-INVERT Gates



MC411/MC461 MC511/MC561

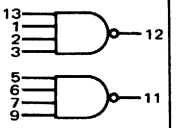
Dual 4-Input Expander for NAND Gates



DRIVER

MC407/MC457 MC507/MC557

Dual 4-Input Line Driver



$12 = \overline{1 \cdot 2 \cdot 3 \cdot 13}$

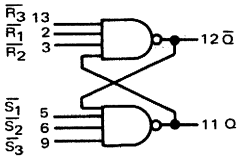
t_{pd} = 25 ns typ
@ 1000 pF Load

P_D = 60 mW typ/pkg

FLIP-FLOPS

MC413/MC463 MC513/MC563

R-S Flip-Flop



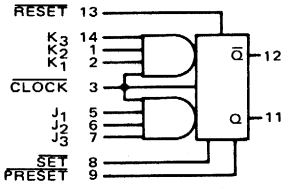
$\overline{R}$	$\overline{S}$	Q_{n+1}	$\overline{Q}_{n+1}$
0	0	Not allowed	
0	1	0	1
1	0	1	0
1	1	Q_n	$\overline{Q}_n$

Where $\overline{R} = \overline{R}_1 \cdot \overline{R}_2 \cdot \overline{R}_3$
$\overline{S} = \overline{S}_1 \cdot \overline{S}_2 \cdot \overline{S}_3$

f = 20 MHz
P_D = 30 mW

MC415/MC465 MC515/MC565

AND J-K Flip-Flop



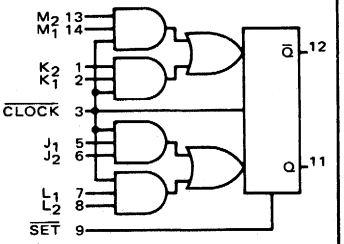
J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Where $J = J_1 \cdot J_2 \cdot J_3$
$K = K_1 \cdot K_2 \cdot K_3$

f = 20 MHz
P_D = 40 mW

MC416/MC466 MC516/MC566

OR J-K Flip-Flop



J	L	K	M	Q_n	Q_{n+1}
0	0	X	X	0	0
1	X	X	X	0	1
X	1	X	X	0	1
X	X	0	0	1	1
X	X	1	X	1	0
X	X	X	1	1	0

X = Don't Care

Where $J = J_1 \cdot J_2$
$L = L_1 \cdot L_2$
$K = K_1 \cdot K_2$
$M = M_1 \cdot M_2$

f = 20 MHz
P_D = 50 mW

MTTL

GENERAL INFORMATION SECTION

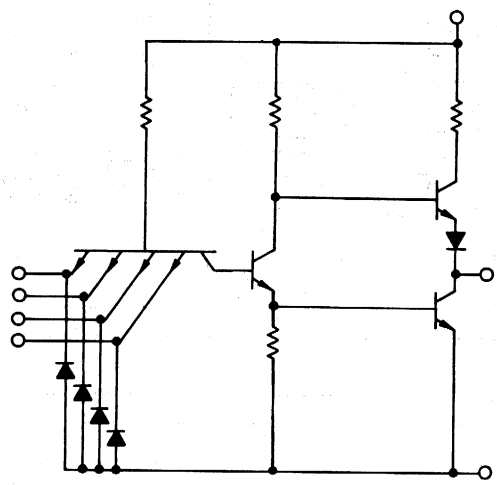
INTRODUCTION

MTTL transistor-transistor logic is a medium speed, high-noise-immunity family of saturating integrated logic circuits.

The circuits in the MTTL family are identified by a multiple emitter input transistor and an active "pull-up" in the upper output network as shown in Figure 1.

The multiple emitter input configuration offers the maximum amount of logic capability in the minimum physical area and provides improved switching characteristics during turnoff. Clamp diodes are provided at each of the inputs to limit undershoot that occurs in typical system applications such as driving long interconnect wiring. The active pull-up output configuration provides low impedance in the high output state. The resulting low impedances in both states provide excellent ac noise immunity and allow high-speed operation while driving large capacitive loads.

FIGURE 1 – TYPICAL MTTL CIRCUIT



MAXIMUM RATINGS

Rating	Value	Unit
Supply Voltage – Continuous MC500 Series MC400 Series	+8.0 +7.0	Vdc
Supply Operating Voltage Range	4.5 to 6.0	Vdc
Input Voltage	+5.5	Vdc
Output Voltage	+5.5	Vdc
Operating Temperature Range MC500 Series MC400 Series	-55 to +125 0 to +75	°C
Storage Temperature Range Flat Package Plastic Package	-65 to +200 -55 to +125	°C
Maximum Junction Temperature MC500/550 Series MC400/450 Series	 +175 +150	°C
Thermal Resistance - Junction To Case (θ_{JC}) Ceramic Flat Package Plastic Dual-In-Line	 0.09 0.15	°C/mW
Thermal Resistance - Junction To Ambient (θ_{JA}) Ceramic Flat Package Plastic Dual-In-Line	 0.26 0.30	°C/mW

TYPICAL CHARACTERISTICS

The following summary presents the typical operating characteristics of the MTTL family. Unless otherwise indicated, the parameters are defined for V_{CC} = +5.0 volts and T_A = +25°C.

Supply Voltage Operating Range = 4.5 to 6.0 volts

Operating Temperature Range:
MC500/550 Series = −55 to +125°C
MC400/450 Series = 0 to +75°C

Output Drive Capability
Other Gates (Output Loading Factor):
MC500 Series = 15 MC500 or MC550 Series Gates.
MC550 Series = 7 MC500 or MC550 Series Gates.
MC400 Series = 12 MC400 or MC450 Series Gates.
MC450 Series = 6 MC400 or MC450 Series Gates.

Capacitance = 600 pF

Output Impedance
High State = 70 ohms (unsaturated) nominal
Low State = 10 ohms nominal

Output Voltage Swing = 0.2 to 3.5 volts typical

Input Voltage Limits
+5.5 volts maximum
−0.5 volt minimum

Switching Threshold = 1.5 volts nominal

Input Impedance
High State = 400 k ohms nominal
Low State = 4.0 k ohms nominal

Worst-Case DC Noise Margin
High State — MC500/550 series 0.700 volt minimum; MC400/450 series 0.600 volt minimum
Low State — MC500/550 series 0.750 volt minimum; MC400/450 series 0.750 volt minimum

Power Dissipation
15 mW per gate typical
40-50 mW per flip-flop typical

Switching Speeds[1]
Average Propagation Delay = 10 ns per gate typical
18 ns per flip-flop typical

Rise Time = 2.5 ns typical
Fall Time = 1.5 ns typical

Flip-Flop Clock Frequency (MC515/516 Series) = 20 MHz maximum.

BREADBOARDING SUGGESTIONS

When breadboarding with any form of high-speed, high-performance TTL, the designer must continually be aware of the fact that he is working with the fastest form of saturating logic available in the industry today. The switching speeds, especially the frequencies associated with the very fast rise and fall times of the circuits, are in the RF range and good high-frequency layout techniques should be used. The following breadboarding suggestions have been included to help the designer in his initial circuit layout. In many cases the breadboarding suggestions will have to be modified to meet the requirements of the designer's specific application.

Power and Ground Distribution

Special care should be taken to insure adequate distribution of power and ground systems. The typical rate of change of currents and voltages for a single MTTL gate is in the range of 10^7 A/s and 10^8 V/s respectively. These figures reflect the necessity for a low-impedance power supply and ground distribution system, if transients are to be minimized and noise margins maintained. The use of AWG No. 20 wire or larger is often required. For printed circuitry, line widths of 100 mils or more are often necessary. A ground plane is desirable when using a large number of units.

Bypassing

To reduce supply transients, the breadboard should be bypassed at the point where power is supplied to the board and at intervals throughout the board. The use of a single bypass capacitor at the output terminal of the power supply is not adequate in a breadboard utilizing the fast rise and fall time MTTL circuits. A comparatively large, low-inductance type capacitor (in the 1.0 μF range) is suggested at the point where power and ground enter the board. In many cases it has been found that distributing 0.01 μF capacitors for every eight packages throughout a breadboard is adequate to supress normal switching transients. It is also suggested that a bypass capacitor be placed in close proximity to any circuit driving a large capacitive load.

Power Dissipation

The standard supply voltage of the MTTL logic circuits is +5.0 Vdc. The typical average dc power dissipation is given for each MTTL circuit.[2] It should be noted that the totem pole output common to all high level MTTL circuits has an associated ac power dissipation factor. This factor results from the timing overlap of the upper and lower output transistors during the normal switching operation and is typically 0.35 mW/MHz/output for a 15 pF load. This ac power dissipation should be added when calculating the total power requirements of the MTTL circuits.

Unused Inputs and Unused Gates

The unused inputs of any MTTL logic circuit should not be left open, and can either be tied to the used inputs or returned to the supply voltage. This will reduce any potential problems resulting from external noise. If the inputs are returned to the supply voltage, care should be taken to insure that the supply voltage does not exceed the maximum rated input voltage of 5.5 volts. If the supply can exceed 5.5 volts, the unused inputs must be returned to a lower voltage. The total number of inputs that can be tied to the output of any driving gate is 50. (This is defined as high state output loading factor.) It should be noted that the low state output loading rules must still be maintained. The minimum logical "1" level for the high state output loading is summarized for V_{CC} = 5.0 V, V_{IL} = 0.45 V and I_{OH} = −5.0 mA:

MC500/550 Series — V_{OH} = 2.8 volts minimum @ −55°C
MC400/450 Series — V_{OH} = 3.0 volts minimum @ 0°C

The unused inputs of the various flip-flops may be tied back to their associated outputs. To determine which outputs are related to each set of inputs by internal feedback, refer to the circuit schematics.

The inputs of any unused gate in a package should be grounded. This places the gate in its lowest power condition and will help to eliminate unnecessary power drain.

Expanders and Expander Nodes

The ORing nodes of all the MTTL AND-OR-INVERT gates are made available for expanding the number of AND gates to 10. Since these are comparatively high-impedance nodes, care should be taken to minimize capacitive loading on the expander terminals if switching speed is to be maintained. When an expander is to be used with an expandable AND-OR-INVERT gate, it should be placed as close as possible to the gate being expanded. The increase in the average propagation delay per AND gate added to an expandable AND-OR-INVERT gate is typically 1.0 ns/AND gate. The increase in average propagation delay as a function of capacitance added to the expander nodes is typically 1.0 ns/pF.

Output OR (AND) Function

Unlike the MDTL family of logic circuits, the outputs of the MTTL logic circuits cannot be tied together to perform the output OR, or more correctly, the output AND function. If the outputs of the MTTL family devices are tied together, it would be possible for the lower output transistor of one circuit and the upper output transistor of another circuit to be "on" simultaneously. This condition provides a low-impedance path from V_{CC} to ground and the current that flows (approximately I_{SC}) exceeds the guaranteed sink current. As a result, the saturated state cannot be maintained and the desired logic function is not satisfied.

Operating Characteristics of Flip-Flops

The general operating characteristics and restrictions for the MC515/MC516 series J-K flip-flops are as follows:

The clocked inputs are inhibited when the clock is in the low state, and data should be applied and allowed to settle. The clocked inputs are enabled when the clock goes high and data enters the flip-flop. The data is temporarily stored in the charge-storage section (temporary memory) while the clock is in the high state. This data is transferred to the bistable section on the negative clock transition.

The data on the clocked inputs should not be changed while the clock is in the high state. Data changes during this clock condition require 300 ns settling time.

The direct $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ inputs do not directly affect the charge-storage section and therefore should not be used while the clock is high. On the negative transition of the clock, previously stored data may override the asynchronous set output state. Further, the direct $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ inputs do not override the clock and will not control the state of the flip-flop until 120 ns after the negative transition of the clock. The clock signal must conform to the following boundary conditions at +125°C.

Maximum guaranteed clock frequency	= 20 MHz
Maximum clock fall time	= 150 ns
Minimum clock pulse width	= 20 ns
Minimum clock pulse amplitude	= 1.8 V
Maximum negative clock voltage	= −0.5 V

Note: These boundary conditions for operation are not defined as occuring simultaneously.

The transfer of data from the charge storage section to the bistable section is essentially an ac operation and thus results in the restriction of the clock fall time. If the clock fall time is greater than 150 ns, the information retained in the charge-storage section may not be transferred to the bistable section. The flip-flop will operate from very low frequencies to 20 MHz as long as the clock fall time is less than or equal to 150 ns.

Large negative clock excursions may cause incorrect data transfers to the bistable section during the transfer cycles. Therefore, the most negative clock signal should be limited to −0.5 volt.

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(1) The switching characteristics of the MTTL family are defined with respect to the associated transitions of the voltage waveforms. The average propagation delay is defined as the average of the turn-on delay and the turn-off delay measured from the 1.5 V point of the input to the 1.5 V point of the associated output transition or:

$$t_{pd} = \frac{t_{on} + t_{off}}{2} \text{ ns.}$$

Rise time is defined as the positive going transition of the output from the 1.0 V to the 2.0 V level. Fall time is defined as the negative transition of the output from the 2.0 V to the 1.0 V level.

(2)
$$P_D = \frac{I_{PDL} + I_{PDH}}{2} (V_{CC})$$

where I_{PDL} and I_{PDH} are the typical dc current drains at V_{CC} = +5.0 V.

MC400/450 and MC500/550 MTTL* series integrated circuits are electrically interchangeable with SUHL I† series logic circuits.

SG SF NUMBERS	Description	−55 to +125°C		0 to +75°C	
		Fan-Out = 15	Fan-Out = 7	Fan-Out = 12	Fan-Out = 6
SG40-43	Dual 4-Input NAND Gate	MC500	MC550	MC400	MC450
SG50-53	Expandable 2-Wide 2-2-2-3-Input AND-OR-INVERT Gate	MC501	MC551	MC401	MC451
SG60-63	Single 8-Input NAND Gate	MC502	MC552	MC402	MC452
SG90-93	2-Wide 3-Input AND-OR-INVERT Gate with Gated Complement	MC503	MC553	MC403	MC453
SG100-103	Expandable 3-Wide 3-Input AND-OR-INVERT Gate	MC504	MC554	MC404	MC454
SG110-113	Expandable 2-Wide 4-Input AND-OR-INVERT Gate	MC505	MC555	MC405	MC455
SG120-123	Expandable 8-Input NAND Gate	MC506	MC556	MC406	MC456
SG130-133	Line Driver	MC507	MC557	MC407	MC457
SG140-143	Quad 2-Input NAND Gate	MC508	MC558	MC408	MC458
SG150-153	4-Wide 3-2-2-3-Input Expander for AND-OR-INVERT Gates	MC509	MC559	MC409	MC459
SG170-173	Dual 4-Input Expander for AND-OR-INVERT Gates	MC510	MC560	MC410	MC460
SG180-183	Dual 4-Input Expander for NAND Gates	MC511	MC561	MC411	MC461
SG190-193	Triple 3-Input NAND Gate	MC512	MC562	MC412	MC462
SF10-13	R-S Flip-Flop	MC513	MC563	MC413	MC463
SF50-53	AND J-K Flip-Flop	MC515	MC565	MC415	MC465
SF60-63	OR J-K Flip-Flop	MC516	MC566	MC416	MC466
SG70-73	Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate	MC520	MC570	MC420	MC470

*Trademark of Motorola Inc.
†Trademark of Sylvania Electric Products, Inc.

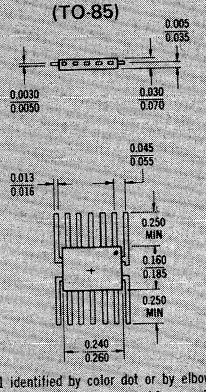
DEFINITIONS

BV_{in} "0"	Input breakdown voltage (ON level)
BV_{in} "1"	Input breakdown voltage (OFF level)
C_T	Total parasitic capacitance, which includes probe, wiring, and load capacitances
f_{Tog}	Toggle frequency
h_{FE}	Forward beta
I_{B1}, I_{B2}	Base current
I_C	Collector Current
I_F	Input forward current
I_{in}	Input current
I_L	Inverse beta current
I_{max}	Maximum rated power supply current with V_{max} applied
I_O	Output breakdown current
I_{OH}	Output high current
I_{OL}	Output low current
I_{OLK}	Output leakage current
I_{PDH}	Power supply drain with inputs high
I_{PDL}	Power supply drain with inputs low
I_R	Input reverse current with V_R applied
I_{SC}	Short circuit current obtained from device output when one or more inputs are low
Pr	Prime fan-out
PRF	Pulse repetition frequency
PW	Pulse width
R_G	Generator resistance
R_L	Load resistance
Std	Standard fan-out
t_f	Fall time
t_{off}	Turn-off delay time
t_{on}	Turn-on delay time
t_{Post}	The minimal time necessary before the $\overline{SET}$, PRESET or $\overline{RESET}$ inputs can control the flip-flop after the negative clock edge
t_r	Rise time
Δt_{pd}	Average increase in propagation delay per AND gate of expander when connected to an AND-OR-INVERT gate
$\Delta t_{pd}/pF$	Increased propagation delay caused by additional capacitance at expansion points
TP_{in}	Test point at input of device under test
TP_{out}	Test point at output of device under test
V_{Amp}	Voltage amplitude
V_{BC}	Base-collector voltage
V_{BE}	Base-emitter voltage
V_C	Collector voltage
V_{CC}	Power supply voltage
V_{CCH}	High power supply voltage
V_{CE}	Collector-emitter voltage
V_{CR}	Collector voltage obtained thru 1.3 k ohm resistor from V_{CC}
V_{CRH}	Collector voltage obtained thru 1.3 k ohm resistor from V_{CCH}
V_{DC}	Voltage obtained with two series diodes tied from collector to ground
V_{E1}, V_{E2}, V_{E3}	Emitter voltage
V_{EN}	Enable voltage level
V_{IH}	Voltage for high input voltage state
V_{IHX}	Reduced supply voltage to hold input above threshold and to prevent noise from entering the device
V_{IL}	Voltage for low input voltage state
V_{INH}	Inhibit voltage level
V_{max}	Maximum rated power supply voltage (V_{CC})
V_O	Offset voltage
V_{OH}	Output high voltage with I_{OH} flowing out of pin
V_{OL}	Output low voltage with I_{OL} flowing into pin
V_{out}	Output voltage
V_{out} "0"	Output low voltage with V_{th} "1" applied
V_{out} "1"	Output high voltage with V_{th} "0" applied
V_R	Input reverse voltage
V_{th} "0"	Logic "0" threshold voltage
V_{th} "1"	Logic "1" threshold voltage

PACKAGING

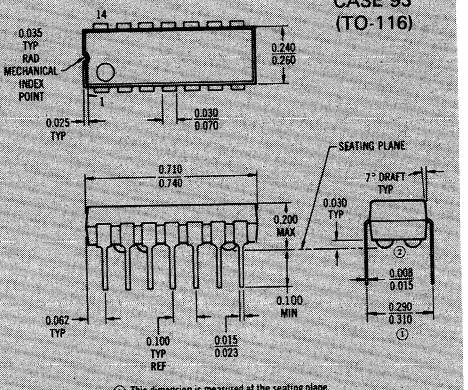
All MTTL integrated circuits are available in the TO-85, 14-lead flat package. MC400 series is also available in the 14-lead dual in-line plastic package. To order the flat package, add suffix "F" to the basic type number; to order plastic package, add suffix "P".

CASE 609
(TO-85)



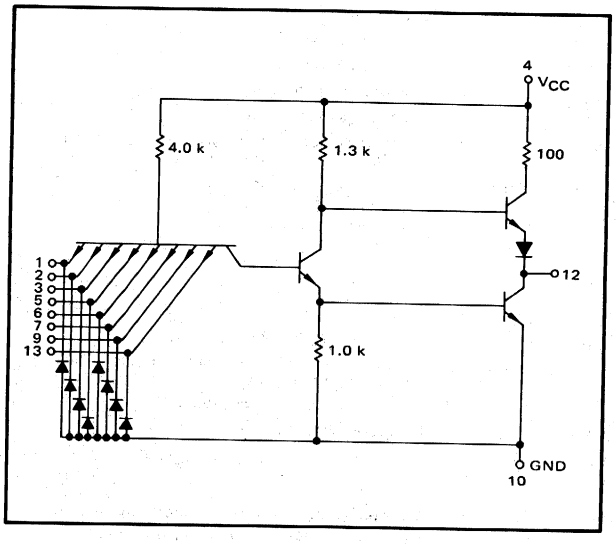
Lead 1 identified by color dot or by elbow on lead. All leads electrically isolated from package.

CASE 93
(TO-116)

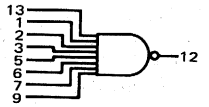


① This dimension is measured at the seating plane.
② 4 insulating stand-offs are provided.

MC502 · MC552
MC402 · MC452



This device is an 8-input NAND gate. It is useful when processing a large number of variables, such as in encoders or decoders.



Positive Logic:

$12 = \overline{1 \cdot 2 \cdot 3 \cdot 5 \cdot 6 \cdot 7 \cdot 9 \cdot 13}$

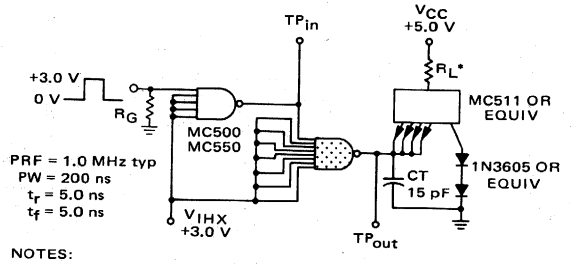
Negative Logic:

$12 = \overline{1 + 2 + 3 + 5 + 6 + 7 + 9 + 13}$

Total Power Dissipation = 15 mW typ/pkg
Propagation Delay Time = 12 ns typ

SERIES	INPUT LOADING FACTOR	(I_F)	OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC502 MC552	1	(−1.33 mA)	15 7	MC500 series Gates MC500 series Gates	(20 mA) (10 mA)	−55°C to +125°C
MC402 MC452	1	(−1.66 mA)	12 6	MC400 series Gates MC400 series Gates	(20 mA) (10 mA)	0° to +75°C

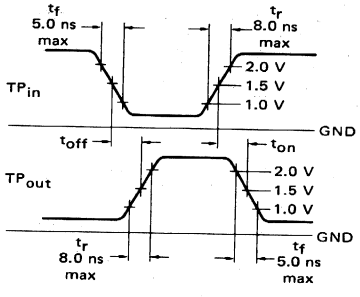
SWITCHING TIME TEST CIRCUITS



NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF

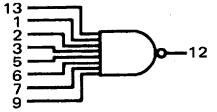
*MC500 – 260Ω
MC550 – 570Ω
MC400 – 330Ω
MC450 – 660Ω

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input of the gate. To complete testing, sequence through remaining inputs in the same manner.



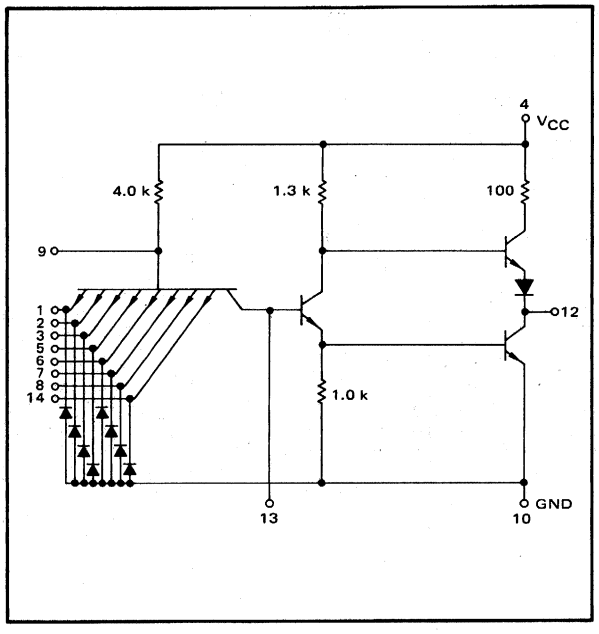
@ Test Temperature		I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	$V_{th\,1}$ Volts	$V_{th\,0}$ Volts	V_{out} Volts	V_{CC} Volts	V_{CCH} Volts	V_{IHX} Volts
MC502*, MC552	−55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0	-	-
	+25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0	8.0	3.0
	+125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0	-	-
MC402*, MC452	0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0	-	-
	+25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0	7.0	3.0
	+75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0	-	-

Characteristic	Symbol	Pin Under Test	MC502, MC552 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC402, MC452 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd
Input																												
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	2,3,5,6, 7,9,13	-	-	-	4	-	-	1,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,5,6,7, 9,10,13
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	10
Breakdown Voltage	BV_{in} "0"	1	-	-	-	5.5	-	-	-	-	-	5.5	-	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	10
	BV_{in} "1"	1	-	-	-	5.5	-	-	-	-	-	5.5	-	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,5,6,7, 9,10,13
Output																												
Output Voltage	V_{out} "0"	12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	1	-	-	4	-	-	10
	V_{out} "1"	12	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	1	-	4	-	-	10
Leakage Current	I_{OLK}	12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	12	4	-	-	1,2,3,5,6, 7,9,10,13
Short-Circuit Current	I_{SC}	12	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6, 7,9,10,13
Output Voltage	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	1	-	-	-	-	4	-	-	10
	V_{OH}	12	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	12	-	1	-	-	-	-	-	4	-	-	10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	10	-	-	-	-	-	10	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,10
Power Supply Drain	I_{PDH}	4	-	6.0	-	6.0	-	6.0	-	7.5	-	7.5	-	7.5	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10
	I_{PDL}	4	-	3.0	-	3.0	-	3.0	-	3.0	-	3.0	-	3.0	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,10
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,12	-	-	-	24	-	-	-	-	-	24	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,9,13	10
Turn-Off Delay	t_{off}	1,12	-	-	-	20	-	-	-	-	-	20	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,9,13	10
Rise Time	t_r	1,12	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,9,13	10
Fall Time	t_f	1,12	-	-	-	5.0	-	-	-	-	-	5.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,9,13	10

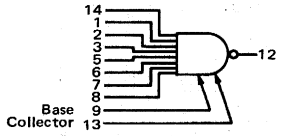
*Prime Fan-Out.

EXPANDABLE 8-INPUT "NAND" GATE

MC506 · MC556
MC406 · MC456



This device consists of an 8-input AND gate driving an output inverter. The base and the collector of the multiple emitter input transistor are available as expander terminals. The number of inputs can be expanded to 20 by using the MC511 series expanders. Care should be taken to minimize the amount of capacitance on the expander terminals in order to maintain switching speeds.



Positive Logic:

$$12 = \overline{1 \cdot 2 \cdot 3 \cdot 5 \cdot 6 \cdot 7 \cdot 8 \cdot 14 \cdot \text{Expanders}}$$

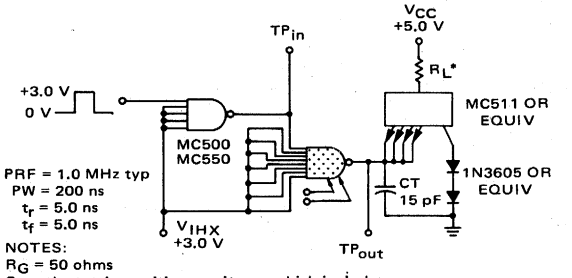
Negative Logic:

$$12 = \overline{1 + 2 + 3 + 5 + 6 + 7 + 8 + 14 + \text{Expanders}}$$

Total Power Dissipation = 15 mW typ/pkg
Propagation Delay Time = 18 ns typ

SERIES	INPUT LOADING FACTOR	(I_F)	OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC506 MC556	1	(−1.33 mA)	15 7	MC500 series Gates MC500 series Gates	(20 mA) (10 mA)	−55°C to +125°C
MC406 MC456	1	(−1.66 mA)	12 6	MC400 series Gates MC400 series Gates	(20 mA) (10 mA)	0° to +75°C

SWITCHING TIME TEST CIRCUIT

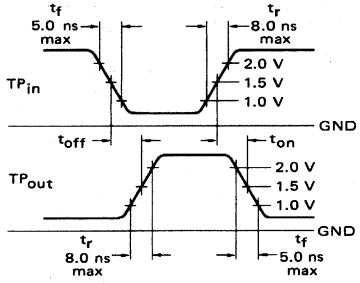


PRF = 1.0 MHz typ
PW = 200 ns
t_r = 5.0 ns
t_f = 5.0 ns

NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Expander pins should be left open when measuring switching times.

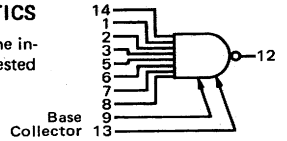
*MC506 – 260 Ω
MC556 – 570 Ω
MC406 – 330 Ω
MC456 – 660 Ω

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input of the gate. The other inputs are tested in the same manner.



	@ Test Temperature	I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	V_{th1} Volts	V_{th0} Volts	V_{out} Volts	V_{CC} Volts	V_{CCH} Volts	V_{IHX} Volts
MC506*, MC556	−55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0	-	-
	+25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0	8.0	3.0
	+125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0	-	-
MC406*, MC456	0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0	-	-
	+25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0	7.0	3.0
	+75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0	-	-

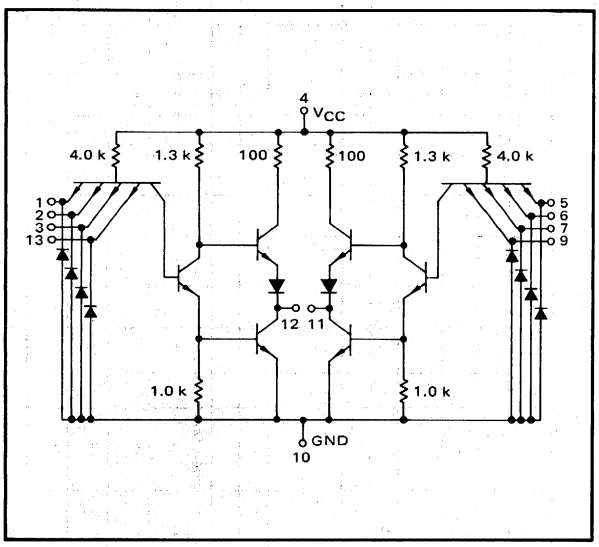
Characteristic	Symbol	Pin Under Test	MC506, MC556 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC406, MC456 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	V_{th1}	V_{th0}	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd
Input Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	2,3,5,6, 7,8,14	-	-	-	4	-	-	1,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,5,6,7, 8,10,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	10
Breakdown Voltage	BV_{in}"0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	10
	BV_{in}"1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,5,6,7, 8,10,14
Output Output Voltage	V_{out} "0"	12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	1	-	-	4	-	-	10
	V_{out} "1"	12	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	1	-	4	-	-	10
Leakage Current	I_{OLK}	12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	12	4	-	-	1,2,3,5,6, 7,8,10,14
Short-Circuit Current	I_{SC}	12	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6,7, 8,10,12,14
Output Voltage	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	1	-	-	-	-	4	-	-	10
	V_{OH}	12	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	12	-	1	-	-	-	-	-	4	-	-	10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	10	-	-	-	-	-	10	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,10
Power Supply Drain	I_{PDH}	4	-	6.0	-	6.0	-	6.0	-	7.5	-	7.5	-	7.5	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10
	I_{PDL}	4	-	3.0	-	3.0	-	3.0	-	3.0	-	3.0	-	3.0	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,10
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}†	1,12	-	-	-	28	-	-	-	-	-	28	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,8,14	10
Turn-Off Delay	t_{off}	1,12	-	-	-	20	-	-	-	-	-	20	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,8,14	10
Rise Time	t_r	1,12	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,8,14	10
Fall Time	t_f	1,12	-	-	-	5.0	-	-	-	-	-	5.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,8,14	10

* Prime Fan-Out.

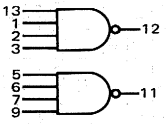
† Add 3.0 ns for each AND expander (1/2 MC511, MC561, MC411, and MC461) used.
Add 2.0 ns t_{pd} for each pF added to either expander points.

DUAL 4-INPUT "NAND" GATE

MC500 · MC550
MC400 · MC450



This device consists of two 4-input NAND gates. The gates can be cross-coupled to form a multiple-input R-S flip-flop or a circuit for eliminating contact bounce.

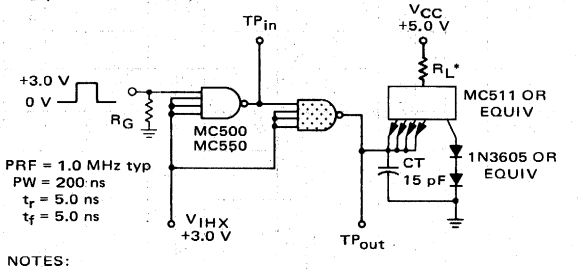


Positive Logic:
$12 = \overline{1 \cdot 2 \cdot 3 \cdot 13}$
Negative Logic:
$12 = \overline{1 + 2 + 3 + 13}$

Total Power Dissipation = 30 mW typ/pkg
Propagation Delay Time = 10 ns typ

SERIES	INPUT LOADING FACTOR	(I_F)	OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC500 MC550	1	(−1.33 mA)	15 7	MC500 series Gates MC500 series Gates	(20 mA) (10 mA)	−55°C to +125°C
MC400 MC450	1	(−1.66 mA)	12 6	MC400 series Gates MC400 series Gates	(20 mA) (10 mA)	0° to +75°C

SWITCHING TIME TEST CIRCUIT

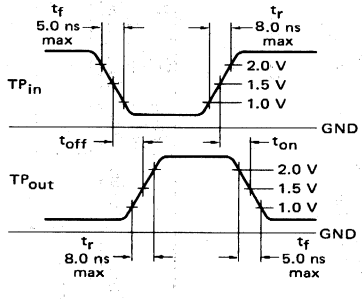


PRF = 1.0 MHz typ
PW = 200 ns
t_r = 5.0 ns
t_f = 5.0 ns

NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Ground inputs to all gates not under test.

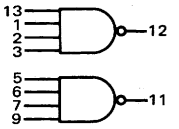
*MC500 — 260 Ω
MC550 — 570 Ω
MC400 — 330 Ω
MC450 — 660 Ω

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gate is tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.



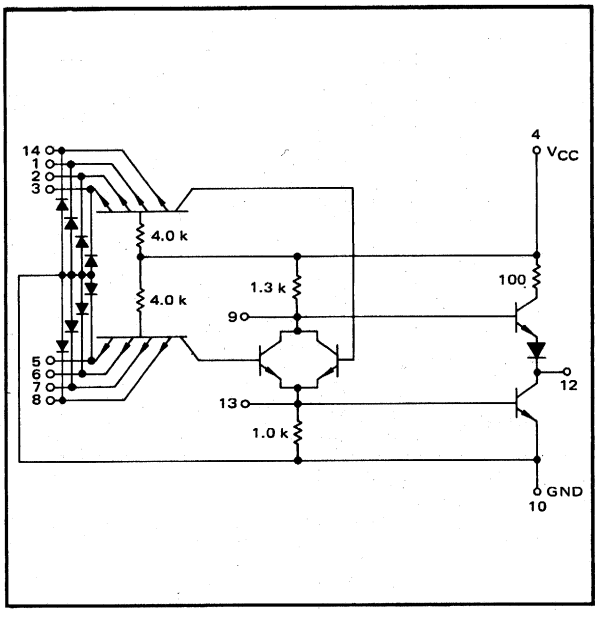
@ Test Temperature	TEST CONDITIONS mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	TEST CONDITIONS Volts V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}
MC500*, MC550 −55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0	-	-
MC500*, MC550 +25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0	8.0	3.0
MC500*, MC550 +125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0	-	-
MC400*, MC450 0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0	-	-
MC400*, MC450 +25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0	7.0	3.0
MC400*, MC450 +75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0	-	-

Characteristic	Symbol	Pin Under Test	MC500, MC550 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC400, MC450 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd †
Input Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	2,3,13	-	-	-	4	-	-	1,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,10,13
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,10,13
Output Output Voltage	V_{out} "0"	12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	1	-	-	4	-	-	10
	V_{out} "1"	12	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	1	-	4	-	-	10
Leakage Current	I_{OLK}	12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	12	4	-	-	1,2,3, 10,13
Short-Circuit Current	I_{SC}	12	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3, 10, 12, 13
Output Voltage	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	1	-	-	-	-	4	-	-	10
	V_{OH}	12	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	12	-	1	-	-	-	-	-	4	-	-	10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	10	-	-	-	-	-	10	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	-	1,5,10
Power Supply Drain	I_{PDH}	4	-	12	-	12	-	12	-	15	-	15	-	15	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10‡
	I_{PDL}	4	-	6.0	-	6.0	-	6.0	-	6.0	-	6.0	-	6.0	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,5,10
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,12	-	-	-	20	-	-	-	-	-	20	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,13	10
Turn-Off Delay	t_{off}	1,12	-	-	-	20	-	-	-	-	-	20	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,13	10
Rise Time	t_r	1,12	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,13	10
Fall Time	t_f	1,12	-	-	-	5.0	-	-	-	-	-	5.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,13	10

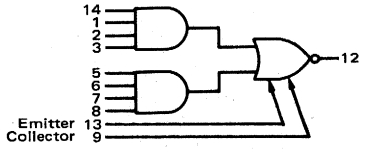
* Prime Fan-Out.
† Ground inputs to gates not under test during ALL tests, unless otherwise noted.
‡ The inputs of all gates must be ungrounded.

EXPANDABLE 2-WIDE 4-INPUT "AND-OR-INVERT" GATE

MC505 · MC555
MC405 · MC455



This device consists of two 4-input AND gates ORed together and driving an output inverter. The ORing nodes are available for expansion and up to 10 AND gates can be ORed together using the MC509 or MC510 series expanders. Care should be taken to minimize the amount of capacitance on the expander terminals in order to maintain switching speeds



Positive Logic:

$12 = (1 \cdot 2 \cdot 3 \cdot 14) + (5 \cdot 6 \cdot 7 \cdot 8) + (\text{Expanders})$

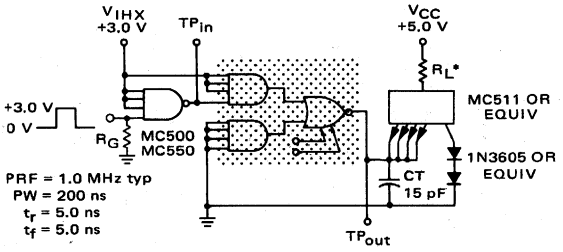
Negative Logic:

$12 = (1 + 2 + 3 + 14) \cdot (5 + 6 + 7 + 8) \cdot (\text{Expanders})$

Total Power Dissipation = 20 mW typ/pkg
Propagation Delay Time = 12 ns typ

SERIES	INPUT LOADING FACTOR	(I_F)	OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC505 MC555	1	(−1.33 mA)	15 7	MC500 series Gates MC500 series Gates	(20 mA) (10 mA)	−55°C to +125°C
MC400 MC450	1	(−1.66 mA)	12 6	MC400 series Gates MC400 series Gates	(20 mA) (10 mA)	0° to +75°C

SWITCHING TIME TEST CIRCUIT

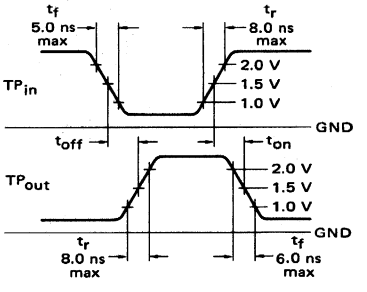


PRF = 1.0 MHz typ
PW = 200 ns
t_r = 5.0 ns
t_f = 5.0 ns

NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Expander pins should be left open when measuring switching times.

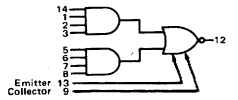
*MC505 – 260 Ω
MC555 – 570 Ω
MC405 – 330 Ω
MC455 – 660 Ω

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input of the device. To complete testing sequence through remaining inputs in the same manner.



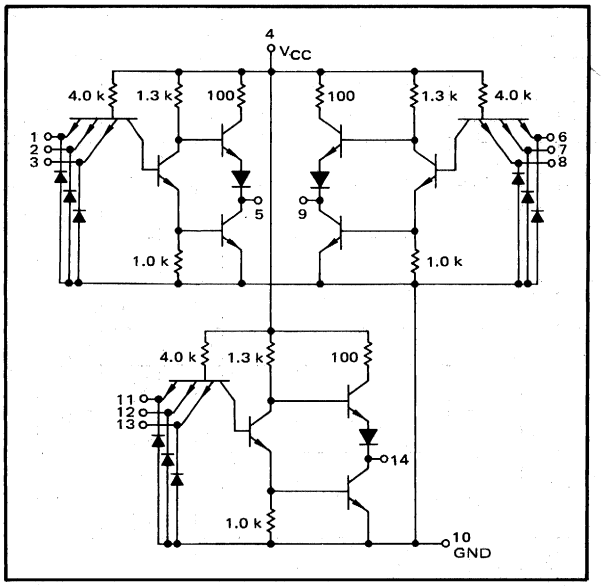
@ Test Temperature		I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	$V_{th\,1}$ Volts	$V_{th\,0}$ Volts	V_{out} Volts	V_{CC} Volts	V_{CCH} Volts	V_{IHX} Volts
MC505*, MC555	−55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0	-	-
	+25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0	8.0	3.0
	+125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0	-	-
MC405*, MC455	0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0	-	-
	+25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0	7.0	3.0
	+75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0	-	-

Characteristic	Symbol	Pin Under Test	MC505, MC555 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC405, MC455 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd
Input																												
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	2,3,14	-	-	-	4	-	-	1,5,6,7, 8,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,5,6,7, 8,10,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	5,6,7,8,10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	5,6,7,8,10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,5,6,7, 8,10,14
Output																												
Output Voltage	V_{out} "0"	12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	1	-	-	4	-	-	5,6,7,8,10
	V_{out} "1"	12	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	1	-	4	-	-	5,6,7,8,10
Leakage Current	I_{OLK}	12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	12	4	-	-	1,2,3,5,6, 7,8,10,14
Short-Circuit Current	I_{SC}	12	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6, 7,8,10, 12,14
Output Voltage	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	1	-	-	-	-	4	-	-	5,6,7,8,10
	V_{OH}	12	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	12	-	1	-	-	-	-	-	4	-	-	5,6,7,8,10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	10	-	-	-	-	-	10	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3,5,6, 7,8,10,14
Power Supply Drain	I_{PDH}	4	-	7.0	-	7.0	-	7.0	-	9.0	-	9.0	-	9.0	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10
	I_{PDL}	4	-	4.0	-	4.0	-	4.0	-	4.0	-	4.0	-	4.0	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6, 7,8,10,14
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,12	-	-	-	22	-	-	-	-	-	22	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,14	5,6,7,8,10
Turn-Off Delay	t_{off}	1,12	-	-	-	22	-	-	-	-	-	22	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,14	5,6,7,8,10
Rise Time	t_r	1,12	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,14	5,6,7,8,10
Fall Time	t_f	1,12	-	-	-	6.0	-	-	-	-	-	6.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,14	5,6,7,8,10

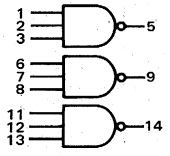
* Prime Fan-Out

TRIPLE 3-INPUT "NAND" GATE

MC512 · MC562
MC412 · MC462



This device consists of a 3-input AND gate driving an output inverter. This gate can be used to build a pulse shaping network for interfacing with discrete component circuits.

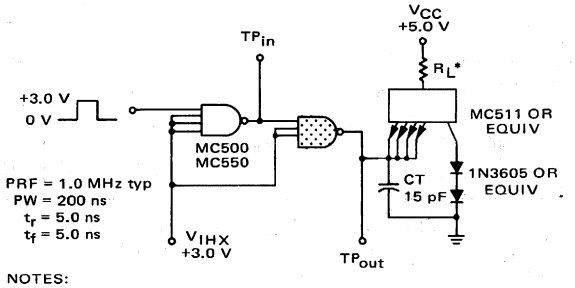


Positive Logic: $5 = \overline{1 \cdot 2 \cdot 3}$
Negative Logic: $5 = \overline{1 + 2 + 3}$

Total Power Dissipation = 45 mW typ/pkg
Propagation Delay Time = 10 ns typ

SERIES	INPUT LOADING FACTOR	(I_F)	OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC512 MC562	1	(−1.33 mA)	15 7	MC500 series Gates MC500 series Gates	(20 mA) (10 mA)	−55°C to +125°C
MC412 MC462	1	(−1.66 mA)	12 6	MC400 series Gates MC400 series Gates	(20 mA) (10 mA)	0° to +75°C

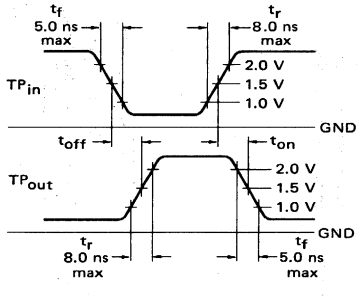
SWITCHING TIME TEST CIRCUIT



NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Ground inputs to all gates not under test.

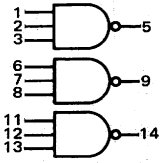
*MC512 – 260Ω
MC562 – 570Ω
MC412 – 330Ω
MC462 – 660Ω

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gates are tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.



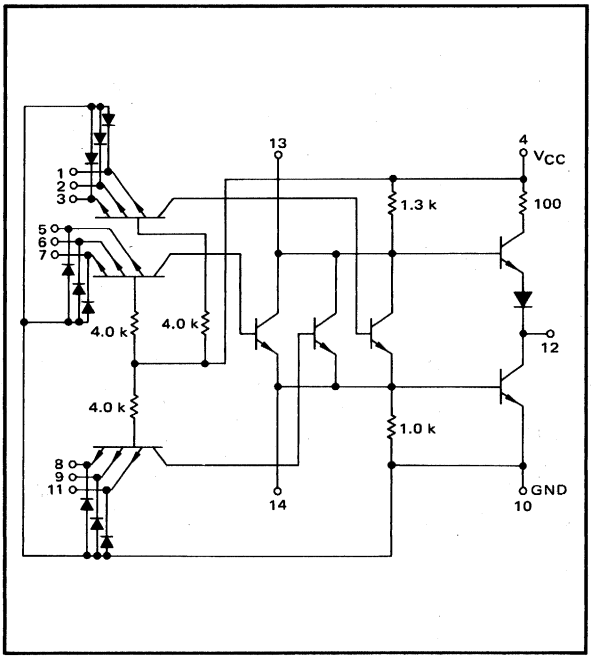
@ Test Temperature		I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	V_{th1} Volts	V_{th0} Volts	V_{out} Volts	V_{CC} Volts	V_{CCH} Volts	V_{IHX} Volts
MC512*, MC562	−55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0	-	-
	+25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0	8.0	3.0
	+125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0	-	-
MC412*, MC462	0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0	-	-
	+25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0	7.0	3.0
	+75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0	-	-

Characteristic	Symbol	Pin Under Test	MC512, MC562 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC412, MC462 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	V_{th1}	V_{th0}	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd†
Input																												
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	2,3	-	-	-	4	-	-	1,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,10
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,10
Output																												
Output Voltage	V_{out} "0"	5	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	5	-	-	-	-	-	1	-	-	4	-	-	10
	V_{out} "1"	5	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	5	-	-	-	-	-	1	-	4	-	-	10
Leakage Current	I_{OLK}	5	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	5	4	-	-	1,2,3,10
Short-Circuit Current	I_{SC}	5	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3, 5,10
Output Voltage	V_{OL}	5	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	5	-	-	-	1	-	-	-	-	4	-	-	10
	V_{OH}	5	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	5	-	1	-	-	-	-	-	4	-	-	10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	15	-	-	-	-	-	15	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,6,10,11
Power Supply Drain	I_{PDH}	4	-	18	-	18	-	18	-	22.5	-	22.5	-	22.5	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10 ‡
	I_{PDL}	4	-	9.0	-	9.0	-	9.0	-	9.0	-	9.0	-	9.0	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,6,10,11
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,5	-	-	-	20	-	-	-	-	-	20	-	-	ns	1	5	-	-	-	-	-	-	-	4	-	2,3	10
Turn-Off Delay	t_{off}	1,5	-	-	-	20	-	-	-	-	-	20	-	-	ns	1	5	-	-	-	-	-	-	-	4	-	2,3	10
Rise Time	t_r	1,5	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	1	5	-	-	-	-	-	-	-	4	-	2,3	10
Fall Time	t_f	1,5	-	-	-	5.0	-	-	-	-	-	5.0	-	-	ns	1	5	-	-	-	-	-	-	-	4	-	2,3	10

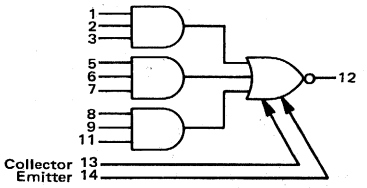
* Prime Fan-Out † Ground inputs to gates not under test, during ALL tests unless otherwise noted. ‡ The inputs to all gates must be ungrounded.

EXPANDABLE 3-WIDE 3-INPUT "AND-OR-INVERT" GATE

MC504 · MC554
MC404 · MC454



This device consists of three 3-input AND gates ORed together driving an output inverter. The common ORing nodes are available for expansion, and up to 10 AND gates can be ORed together using the MC509 or the MC510 series expanders. Care should be taken to minimize the amount of capacitance on the expander terminals in order to maintain switching speeds.



Positive Logic:

$12 = \overline{(1 \cdot 2 \cdot 3) + (5 \cdot 6 \cdot 7) + (8 \cdot 9 \cdot 11)} + (\text{Expanders})$

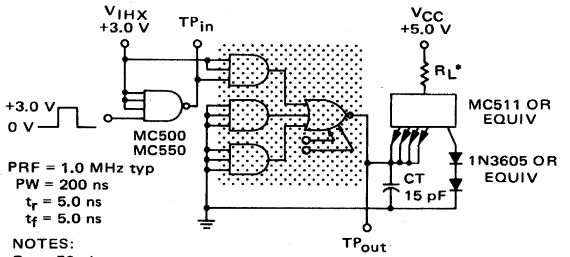
Negative Logic:

$12 = \overline{(1 + 2 + 3) \cdot (5 + 6 + 7) \cdot (8 + 9 + 11)} \cdot (\text{Expanders})$

Total Power Dissipation = 25 mW typ/pkg
Propagation Delay Time = 12 ns typ

SERIES	INPUT LOADING FACTOR	(I_F)	OUTPUT DRIVE	(I_{OL})	TEMPERATURE RANGE
MC504 MC554	1	(−1.33 mA)	15 MC500 series Gates 7 MC500 series Gates	(20 mA) (10 mA)	−55°C to +125°C
MC404 MC454	1	(−1.66 mA)	12 MC400 series Gates 6 MC400 series Gates	(20 mA) (10 mA)	0° to +75°C

SWITCHING TIME TEST CIRCUIT

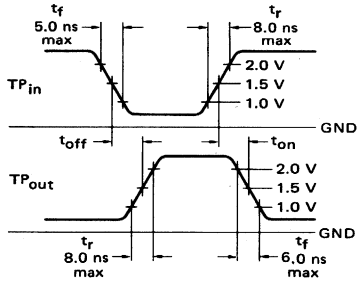


PRF = 1.0 MHz typ
PW = 200 ns
t_r = 5.0 ns
t_f = 5.0 ns

NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Expander pins should be left open when measuring switching times.

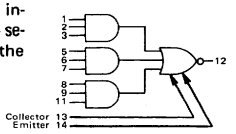
*MC504 — 260 Ω
MC554 — 570 Ω
MC404 — 330 Ω
MC454 — 660 Ω

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input of the device. To complete testing sequence through remaining inputs in the same manner.

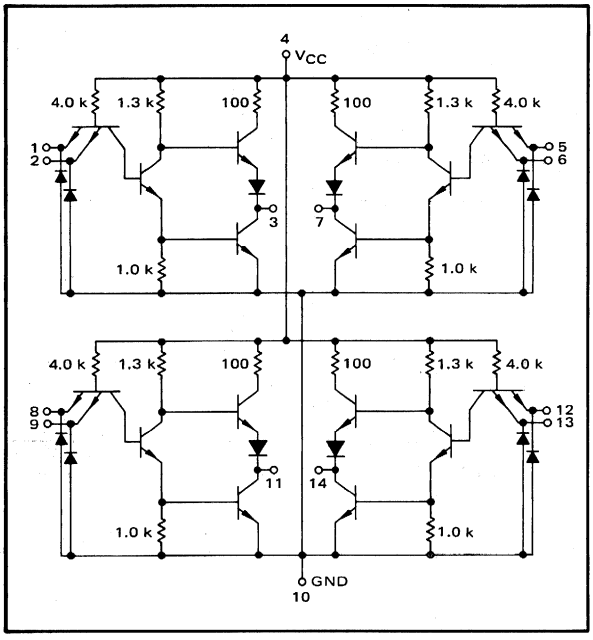


	@ Test Temperature	TEST CONDITIONS mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	Volts V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}
MC504*, MC554	−55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0	-	-
	+25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0	8.0	3.0
	+125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0	-	-
MC404*, MC454	0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0	-	-
	+25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0	7.0	3.0
	+75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0	-	-

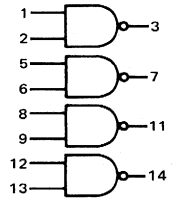
Characteristic	Symbol	Pin Under Test	MC504, MC554 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC404, MC454 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd
Input Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	2,3	-	-	-	4	-	-	1,5,6,7,8,9,10,11
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,5,6,7,8,9,10,11
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	5,6,7,8,9,10,11
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	5,6,7,8,9,10,11
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,5,6,7,8,9,10,11
Output Output Voltage	V_{out} "0"	12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	1	-	-	4	-	-	5,6,7,8,9,10,11
	V_{out} "1"	12	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	1	-	4	-	-	5,6,7,8,9,10,11
Leakage Current	I_{OLK}	12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	12	4	-	-	1,2,3,5,6,7,8,9,10,11
Short-Circuit Current	I_{SC}	12	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6,7,8,9,10,11,12
Output Voltage	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	1	-	-	-	-	4	-	-	5,6,7,8,9,10,11
	V_{OH}	12	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	12	-	1	-	-	-	-	-	4	-	-	5,6,7,8,9,10,11
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	10	-	-	-	-	-	10	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3,5,6,7,8,9,10,11
Power Supply Drain	I_{PDH}	4	-	8.0	-	8.0	-	8.0	-	10	-	10	-	10	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10
	I_{PDL}	4	-	6.0	-	6.0	-	6.0	-	6.0	-	6.0	-	6.0	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6,7,8,9,10,11
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,12	-	-	-	22	-	-	-	-	-	22	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3	5,6,7,8,9,10,11
Turn-Off Delay	t_{off}	1,12	-	-	-	22	-	-	-	-	-	22	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3	5,6,7,8,9,10,11
Rise Time	t_r	1,12	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3	5,6,7,8,9,10,11
Fall Time	t_f	1,12	-	-	-	6.0	-	-	-	-	-	6.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3	5,6,7,8,9,10,11

* Prime Fan-Out

MC508 · MC558
MC408 · MC458



This device consists of four 2-input NAND gates. The four gates in a single package represent increased functional flexibility. For example, a dual set-reset flip-flop may be obtained if each pair of gates is externally cross-coupled.

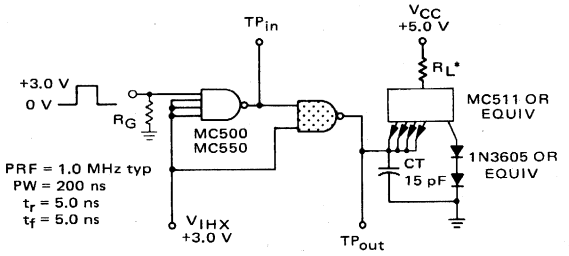


Positive Logic: $3 = \overline{1 \cdot 2}$
Negative Logic: $3 = \overline{1 + 2}$

Total Power Dissipation = 60 mW typ/pkg
Propagation Delay Time = 10 ns typ

SERIES	INPUT LOADING FACTOR	(I_F)	OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC508 MC558	1	(−1.33 mA)	15 7	MC500 series Gates MC500 series Gates	(20 mA) (10 mA)	−55°C to +125°C
MC408 MC458	1	(−1.66 mA)	12 6	MC400 series Gates MC400 series Gates	(20 mA) (10 mA)	0° to +75°C

SWITCHING TIME TEST CIRCUIT

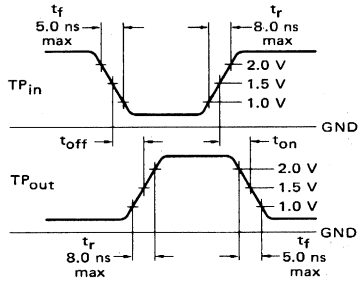


PRF = 1.0 MHz typ
PW = 200 ns
t_r = 5.0 ns
t_f = 5.0 ns

NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Ground inputs to all gates not under test.

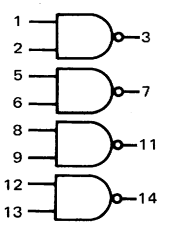
*MC508 – 260 Ω
MC558 – 570 Ω
MC408 – 330 Ω
MC458 – 660 Ω

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gates are tested in a similar manner. Further, test procedures are shown for only one input of the gate being tested. The other input is tested in the same manner.



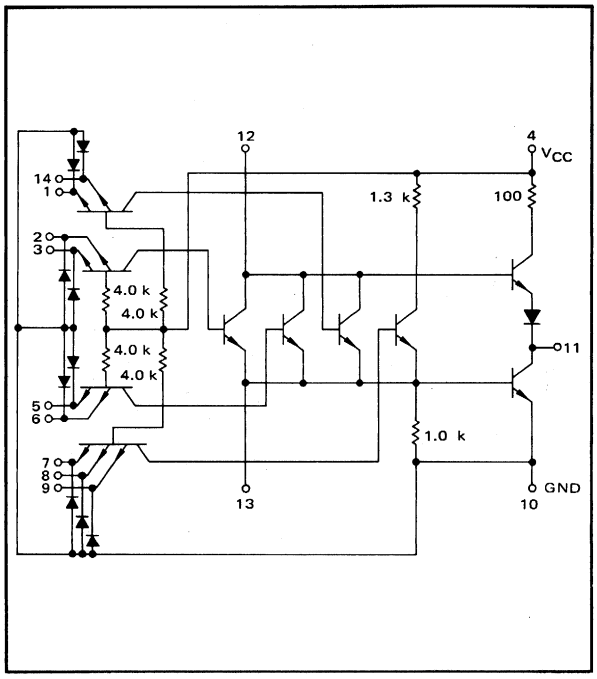
@ Test Temperature		TEST CONDITIONS mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	Volts V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}
MC508*, MC558	−55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0	-	-
	+25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0	8.0	3.0
	+125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0	-	-
MC408*, MC458	0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0	-	-
	+25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0	7.0	3.0
	+75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0	-	-

Characteristic	Symbol	Pin Under Test	MC508, MC558 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC408, MC458 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd†
Input																												
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	2	-	-	-	4	-	-	1,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,10
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,10
Output																												
Output Voltage	V_{out} "0"	3	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	3	-	-	-	-	-	1	-	-	4	-	-	10
	V_{out} "1"	3	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	3	-	-	-	-	-	1	-	4	-	-	10
Leakage Current	I_{OLK}	3	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	3	4	-	-	1,2,10
Short-Circuit Current	I_{SC}	3	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,10
Output Voltage	V_{OL}	3	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	3	-	-	-	1	-	-	-	-	4	-	-	10
	V_{OH}	3	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	3	-	1	-	-	-	-	-	4	-	-	10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	20	-	-	-	-	-	20	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,5,8,10,12
Power Supply Drain	I_{PDH}	4	-	24	-	24	-	24	-	30	-	30	-	30	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10‡
	I_{PDL}	4	-	12	-	12	-	12	-	12	-	12	-	12	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,5,8,10,12
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,3	-	-	-	20	-	-	-	-	-	20	-	-	ns	1	3	-	-	-	-	-	-	-	4	-	2	10
Turn-Off Delay	t_{off}	1,3	-	-	-	20	-	-	-	-	-	20	-	-	ns	1	3	-	-	-	-	-	-	-	4	-	2	10
Rise Time	t_r	1,3	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	1	3	-	-	-	-	-	-	-	4	-	2	10
Fall Time	t_f	1,3	-	-	-	5.0	-	-	-	-	-	5.0	-	-	ns	1	3	-	-	-	-	-	-	-	4	-	2	10

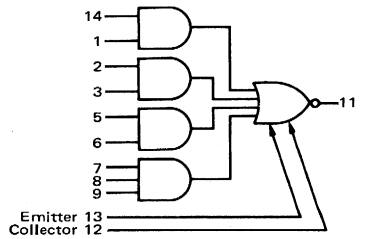
* Prime Fan-Out.
† Ground inputs to gates not under test, during ALL tests unless otherwise noted.
‡ The inputs to all gates must be ungrounded.

EXPANDABLE 4-WIDE 2-2-2-3 INPUT "AND-OR-INVERT" GATE

MC501 · MC551
MC401 · MC451



This device consists of three 2-input and one 3-input AND gates internally ORed together and then inverted to provide the output. The common ORing nodes are available for expansion and up to 10 AND gates can be ORed together using the MC509 and the MC510 series expanders. Care should be taken to minimize the amount of capacitance on the expander terminals in order to maintain switching speeds.



Positive Logic:

$11 = \overline{(14 \cdot 1) + (2 \cdot 3) + (5 \cdot 6) + (7 \cdot 8 \cdot 9) + (\text{Expanders})}$

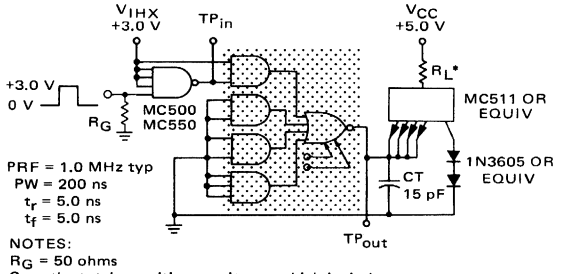
Negative Logic:

$11 = \overline{(14 + 1) \cdot (2 + 3) \cdot (5 + 6) \cdot (7 + 8 + 9) \cdot (\text{Expanders})}$

Total Power Dissipation = 30 mW typ/pkg
Propagation Delay Time = 12 ns typ

SERIES	INPUT LOADING FACTOR	(I_F)	OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC501 MC551	1	(−1.33 mA)	15 7	MC500 series Gates MC500 series Gates	(20 mA) (10 mA)	−55°C to +125°C
MC401 MC451	1	(−1.66 mA)	12 6	MC400 series Gates MC400 series Gates	(20 mA) (10 mA)	0° to +75°C

SWITCHING TIME TEST CIRCUIT

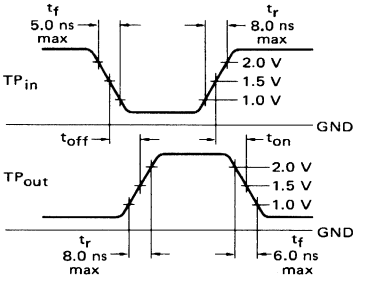


PRF = 1.0 MHz typ
PW = 200 ns
t_r = 5.0 ns
t_f = 5.0 ns

NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Expander pins should be left open when measuring switching times.

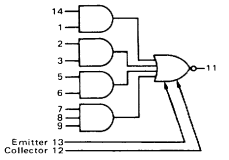
*MC501 – 260 Ω
MC551 – 570 Ω
MC401 – 330 Ω
MC451 – 660 Ω

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for one input of the device. To complete testing, sequence through remaining inputs in a similar manner.



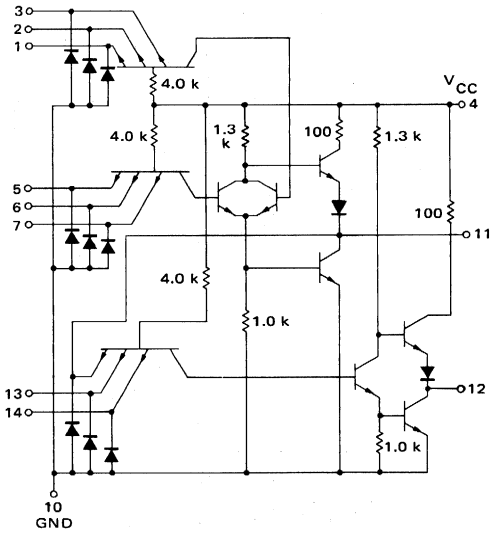
@ Test Temperature		I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	$V_{th\,1}$ Volts	$V_{th\,0}$ Volts	V_{out} Volts	V_{CC} Volts	V_{CCH} Volts	V_{IHX} Volts
MC501*, MC551	−55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0	-	-
	+25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0	8.0	3.0
	+125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0	-	-
MC401*, MC451	0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0	-	-
	+25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0	7.0	3.0
	+75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0	-	-

Characteristic	Symbol	Pin Under Test	MC501, MC551 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC401, MC451 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd
Input																												
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	14	-	-	-	4	-	-	1,2,3,5,6,7,8,9,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,5,6,7,8,9,10,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,5,6,7,8,9,10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,5,6,7,8,9,10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,5,6,7,8,9,10,14
Output																												
Output Voltage	V_{out} "0"	11	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	11	-	-	-	-	-	1	-	-	4	-	-	2,3,5,6,7,8,9,10
	V_{out} "1"	11	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	11	-	-	-	-	-	1	-	4	-	-	2,3,5,6,7,8,9,10
Leakage Current	I_{OLK}	11	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	11	4	-	-	1,2,3,5,6,7,8,9,10,14
Short-Circuit Current	I_{SC}	11	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6,7,8,9,10,11,14
Output Voltage	V_{OL}	11	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	11	-	-	-	1	-	-	-	-	4	-	-	2,3,5,6,7,8,9,10
	V_{OH}	11	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	11	-	1	-	-	-	-	-	4	-	-	2,3,5,6,7,8,9,10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	12	-	-	-	-	-	12	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3,5,6,7,8,9,10,14
Power Supply Drain	I_{PDH}	4	-	9.0	-	9.0	-	9.0	-	11	-	11	-	11	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10
	I_{PDL}	4	-	7.5	-	7.5	-	7.5	-	7.5	-	7.5	-	7.5	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6,7,8,9,10,14
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,11	-	-	-	23	-	-	-	-	-	23	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	14	2,3,5,6,7,8,9,10
Turn-Off Delay	t_{off}	1,11	-	-	-	23	-	-	-	-	-	23	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	14	2,3,5,6,7,8,9,10
Rise Time	t_r	1,11	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	14	2,3,5,6,7,8,9,10
Fall Time	t_f	1,11	-	-	-	6.0	-	-	-	-	-	6.0	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	14	2,3,5,6,7,8,9,10

* Prime Fan-Out.

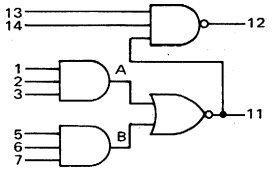
2-WIDE 3-INPUT
"AND-OR-INVERT" GATE
WITH GATED COMPLEMENT

MC503 · MC553
MC403 · MC453



Pin 11 is an output terminal and should not be used as an input.

This device is the only gate of the basic positive AND-OR-INVERT series that includes an additional 3-input AND-INVERT function on the output. This configuration provides the output and a gated complement in a single package. This device is useful in the design of adders, subtracters and one-shot multivibrators.



Positive Logic

$11 = \overline{(1\cdot2\cdot3) + (5\cdot6\cdot7)}$

$12 = \overline{11\cdot13\cdot14}$

$12 = (1\cdot2\cdot3) + (5\cdot6\cdot7) + \overline{13} + \overline{14}$

Total Power Dissipation = 35 mW typ/pkg

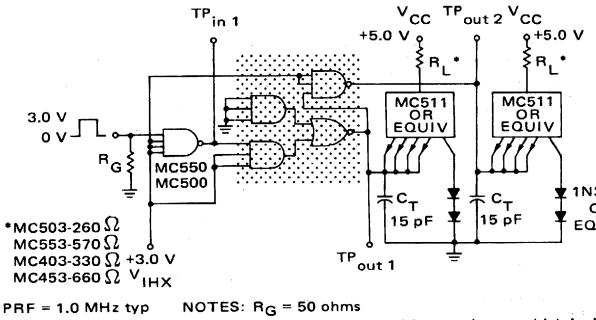
Propagation Delay Times = 11 ns typ (Pin 1 to Pin 11)
10 ns typ (Pin 11 to Pin 12)

TRUTH TABLE

A	B	OUTPUT PIN # 11	PIN #13	PIN #14	OUTPUT PIN # 12
0	1	0	0	0	1
1	0	0	0	1	1
0	1	0	1	0	1
1	0	0	1	1	1
0	0	1	0	0	1
0	0	1	0	1	1
0	0	1	1	0	1
0	0	1	1	1	0

SERIES	INPUT LOADING FACTOR (I_F)		OUTPUT DRIVE (I_{OL})		TEMPERATURE RANGE
MC503 MC553	1	(-1.33 mA)	15 MC500 Series Gates 7 MC500 Series Gates	(20 mA) (10 mA)	-55°C to +125°C
MC403 MC453	1	(-1.66 mA)	12 MC400 Series Gates 6 MC400 Series Gates	(20 mA) (10 mA)	0°C to +75°C

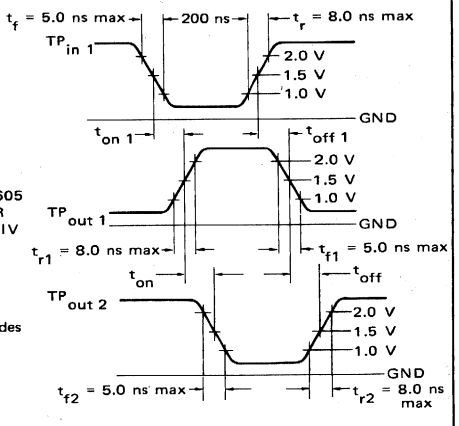
SWITCHING TIME TEST CIRCUIT



PRF = 1.0 MHz typ
PW = 200 ns
t_r = 8.0 ns max
t_f = 5.0 ns max

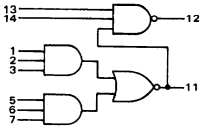
NOTES: R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input of the AND-OR-INVERT gate, plus one input of the gated complement. To complete testing, sequence through remaining inputs in the same manner.



@ Test Temperature		I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	$V_{th\,1}$ Volts	$V_{th\,0}$ Volts	V_{out} Volts	V_{CC} Volts	V_{CCH} Volts	V_{IHX} Volts
MC503*, MC553	−55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0	8.0	-
	+25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0	8.0	3.0
	+125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0	8.0	-
MC403*, MC453	0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0	7.0	-
	+25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0	7.0	3.0
	+75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0	7.0	-

Characteristic	Symbol	Pin Under Test	MC503, MC553 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC403, MC453 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd
Input																												
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	2,3	-	-	-	4	-	-	1,5,6,7,10
		14	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	13	-	-	-	4	-	-	1,2,3,5,6, 7,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,5,6, 7,10
		14	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	14	-	-	-	4	-	-	10,13
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	5,6,7,10
		14	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	14	-	-	-	4	-	-	1,2,3,5,6, 7,10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	5,6,7,10
		14	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	14	-	-	-	-	-	-	4	-	-	1,2,3,5,6, 7,10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,5,6, 7,10
		14	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	14	-	-	-	-	-	-	4	-	-	10,13
Output																												
Output Voltage	V_{out} "0"	11	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	11	-	-	-	-	-	1	-	-	4	-	-	5,6,7,10
		12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	14	-	-	4	-	-	1,2,3,5,6, 7,10
	V_{out} "1"	11	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	11	-	-	-	-	-	1	-	4	-	-	5,6,7,10
		12	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	14	-	4	-	-	1,2,3,5,6, 7,10
Leakage Current	I_{OLK}	11	-	1250	-	1250	-	1250	-	1250	-	1250	-	1250	μAdc	-	-	-	-	-	-	-	-	11	4	-	-	1,2,3,5,6, 7,10
		12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	12	4	-	-	10,13,14
Short-Circuit Current	I_{SC}	11	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6, 7,10,11
		12	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10,12,13,14
Output Voltage	V_{OH}	11	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	11	-	1	-	-	-	-	-	4	-	-	5,6,7,10
		12	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	12	-	14	-	-	-	-	-	4	-	-	1,2,3,5,6, 7,10
	V_{OL}	11	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	11	-	-	-	1	-	-	-	-	4	-	-	5,6,7,10
		12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	14	-	-	-	-	4	-	-	1,2,3,5,6, 7,10

ELECTRICAL CHARACTERISTICS (continued)

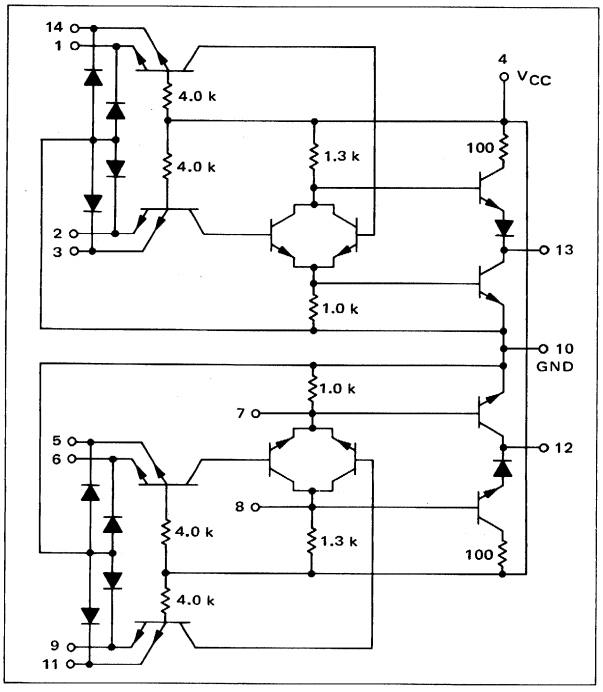
	@ Test Temperature	I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	$V_{th\,1}$ Volts	$V_{th\,0}$ Volts	V_{out} Volts	V_{CC} Volts	V_{CCH} Volts	V_{IHX} Volts
MC503*, MC553	−55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0	8.0	-
	+25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0	8.0	3.0
	+125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0	8.0	-
MC403*, MC453	0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0	7.0	-
	+25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0	7.0	3.0
	+75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0	7.0	-

Characteristic	Symbol	Pin Under Test	MC503, MC553 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC403, MC453 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd
Power Requirements (Total Device)																												
Maximum Power Supply Current	I_{max}	4	-	34	-	34	-	34	-	24	-	24	-	24	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3,5,6, 7,10,13,14
Power Supply Drain	I_{PDH}	4	-	10	-	10	-	10	-	12	-	12	-	12	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10
	I_{PDL}	4	-	10	-	10	-	10	-	12	-	12	-	12	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6, 7,10
		4	-	7.0	-	7.0	-	7.0	-	7.0	-	7.0	-	7.0	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6, 7,10,13,14
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	$t_{on\,1}$	1, 11	-	-	-	22	-	-	-	-	-	22	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	2,3, 13,14	5,6,7,10
	$t_{on\,2}$	11, 12	-	-	-	20	-	-	-	-	-	20	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3, 13,14	5,6,7,10
Turn-Off Delay	$t_{off\,1}$	1, 11	-	-	-	22	-	-	-	-	-	22	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	2,3, 13,14	5,6,7,10
	$t_{off\,2}$	11, 12	-	-	-	20	-	-	-	-	-	20	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3, 13,14	5,6,7,10
Rise Time	$t_{r\,1}$	1, 11	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	2,3, 13,14	5,6,7,10
	$t_{r\,2}$	11, 12	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3, 13,14	5,6,7,10
Fall Time	$t_{f\,1}$	1, 11	-	-	-	6.0	-	-	-	-	-	6.0	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	2,3, 13,14	5,6,7,10
	$t_{f\,2}$	11, 12	-	-	-	5.0	-	-	-	-	-	5.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3, 13,14	5,6,7,10

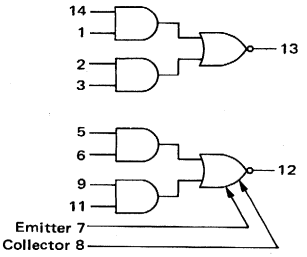
* Prime Fan-Out

EXPANDABLE DUAL 2-WIDE 2-INPUT "AND-OR-INVERT" GATE

MC520 • MC570
MC420 • MC470



One side of this dual device consists of two 2-input AND gates ORed together and driving an output inverter. The other side consists of two 2-input gates ORed together and driving an output inverter with an output inverter with the ORing nodes made available for expansion. Up to 10 AND gates can be ORed together using the MC509 or MC510 expander series. Care should be taken to minimize the amount of capacitance on the expander terminals in order to maintain switching speeds.



Positive Logic:

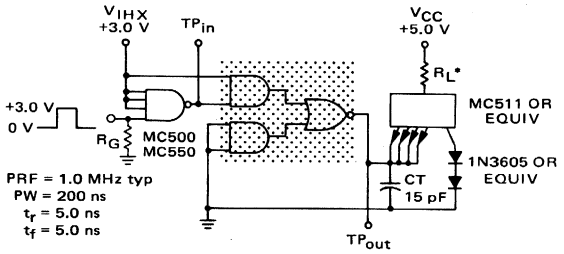
$13 = \overline{(1 \cdot 14) + (2 \cdot 3)}$

$12 = \overline{(5 \cdot 6) + (9 \cdot 11) + (\text{Expander})}$

Total Power Dissipation = 40 mW typ/pkg
Propagation Delay Time = 12 ns typ

SERIES	INPUT LOADING FACTOR	(I_F)	OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC520 MC570	1	(−1.33 mA)	15 7	MC500 series Gates MC500 series Gates	(20 mA) (10 mA)	−55°C to +125°C
MC420 MC470	1	(−1.66 mA)	12 6	MC400 series Gates MC400 series Gates	(20 mA) (10 mA)	0° to +75°C

SWITCHING TIME TEST CIRCUIT

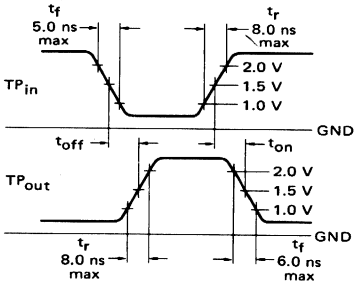


PRF = 1.0 MHz typ
PW = 200 ns
t_r = 5.0 ns
t_f = 5.0 ns

NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
When checking expander side, expander pins should be open.

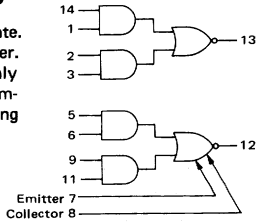
*MC520 – 260 Ω
MC570 – 570 Ω
MC420 – 330 Ω
MC470 – 660 Ω

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gate is tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.

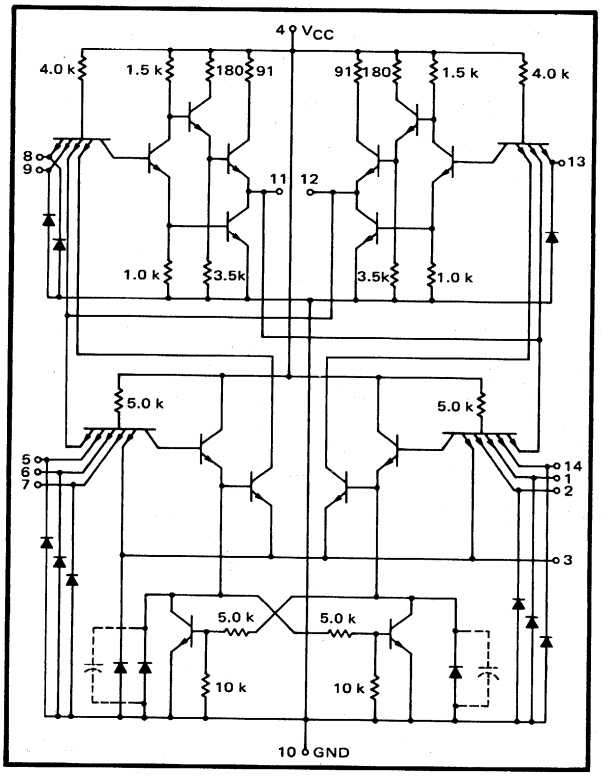


@ Test Temperature		TEST CONDITIONS: mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	Volts V_{IL}	V_{IH}	V_R	V_{th1}	V_{th0}	V_{out}	V_{CC}	V_{CCH}	V_{IHX}
MC520*, MC570	−55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0	-	-
	+25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0	8.0	3.0
	+125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0	-	-
MC420*, MC470	0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0	-	-
	+25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0	7.0	3.0
	+75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0	-	-

Characteristic	Symbol	Pin Under Test	MC520, MC570 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC420, MC470 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	V_{th1}	V_{th0}	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd†
Input																												
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	14	-	-	-	4	-	-	1,2,3,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,10,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,10,14
Output																												
Output Voltage	V_{out} "0"	13	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	13	-	-	-	-	-	1	-	-	4	-	-	2,3,10
	V_{out} "1"	13	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	13	-	-	-	-	-	1	-	4	-	-	2,3,10
Leakage Current	I_{OLK}	13	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	13	4	-	-	1,2,3,10,14
Short-Circuit Current	I_{SC}	13	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,10, 13,14
Output Voltage	V_{OL}	13	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	13	-	-	-	1	-	-	-	-	4	-	-	2,3,10
	V_{OH}	13	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	13	-	1	-	-	-	-	-	4	-	-	2,3,10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	10	-	-	-	-	-	10	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3,10,14
Power Supply Drain	I_{PDH}	4	-	14	-	14	-	14	-	18	-	18	-	18	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10‡
	I_{PDL}	4	-	7.0	-	7.0	-	7.0	-	8.0	-	8.0	-	8.0	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,10,14
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,13	-	-	-	22	-	-	-	-	-	22	-	-	ns	1	13	-	-	-	-	-	-	-	4	-	14	2,3,10
Turn-Off Delay	t_{off}	1,13	-	-	-	22	-	-	-	-	-	22	-	-	ns	1	13	-	-	-	-	-	-	-	4	-	14	2,3,10
Rise Time	t_r	1,13	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	1	13	-	-	-	-	-	-	-	4	-	14	2,3,10
Fall Time	t_f	1,13	-	-	-	6.0	-	-	-	-	-	6.0	-	-	ns	1	13	-	-	-	-	-	-	-	4	-	14	2,3,10

* Prime Fan-Out
† Ground inputs to gates not under test during ALL tests unless otherwise noted.
‡ The inputs to all gates must be ungrounded.

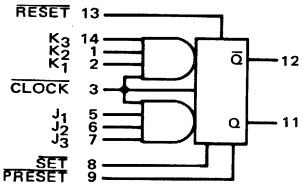
MC515 · MC565
MC415 · MC465



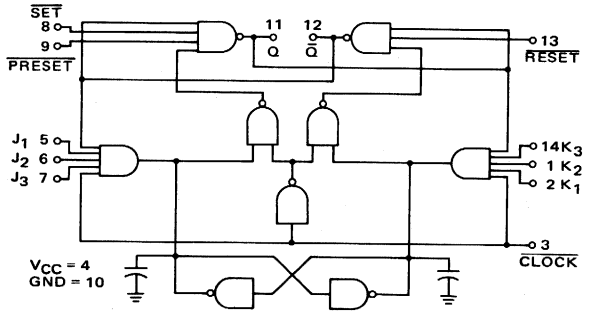
The MC415, MC465, MC515, and MC565 are clocked flip-flops that trigger on the negative edge and perform the J-K logic function. Each flip-flop has an AND input gating configuration consisting of three J inputs ANDed together and three K inputs ANDed together. The multiple J and K inputs minimize the requirements for external gating in counters and certain other applications. A direct $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ are also available.

In normal operation, information is changed on the J and K inputs while the clock is in the low state, since the inputs are inhibited in this condition. Information is read into a temporary memory when the clock is in the high state. When the clock goes low, the information is transferred to the bistable section and the Q and $\overline{Q}$ outputs respond accordingly. The information on the J and K inputs should not be changed while the clock is in the high state. Each flip-flop can be set or reset directly by applying the low state to the direct $\overline{SET}$, $\overline{PRESET}$, or $\overline{RESET}$ inputs.

Since each flip-flop is a charge-storage device, there is a restriction on the clock fall time that must be observed.



EQUIVALENT CIRCUIT



J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Where $J = J_1 \cdot J_2 \cdot J_3$
$K = K_1 \cdot K_2 \cdot K_3$

Total Power Dissipation ≐ 40 mW typ/pkg
Switching Times:
t_{on} = 25 ns typ
t_{off} = 13 ns typ

SERIES	INPUT LOADING FACTOR (I_F)				OUTPUT DRIVE (I_{OL})	TEMPERATURE RANGE
	CLOCK	ALL OTHER	CLOCK	ALL OTHER		
MC515 MC565	1.5	1	(-2.0 mA)	(−1.33 mA)	15 MC500 series Gates (20 mA) 7 MC500 series Gates (10 mA)	−55°C to +125°C
MC415 MC465	1.5	1	(−2.5 mA)	(−1.66 mA)	12 MC400 series Gates (20 mA) 6 MC400 series Gates (10 mA)	0°C to +75°C

OPERATING CHARACTERISTICS

Clock fall time ≤ 150 ns.

Triggers on clock pulse widths ≥ 20ns.

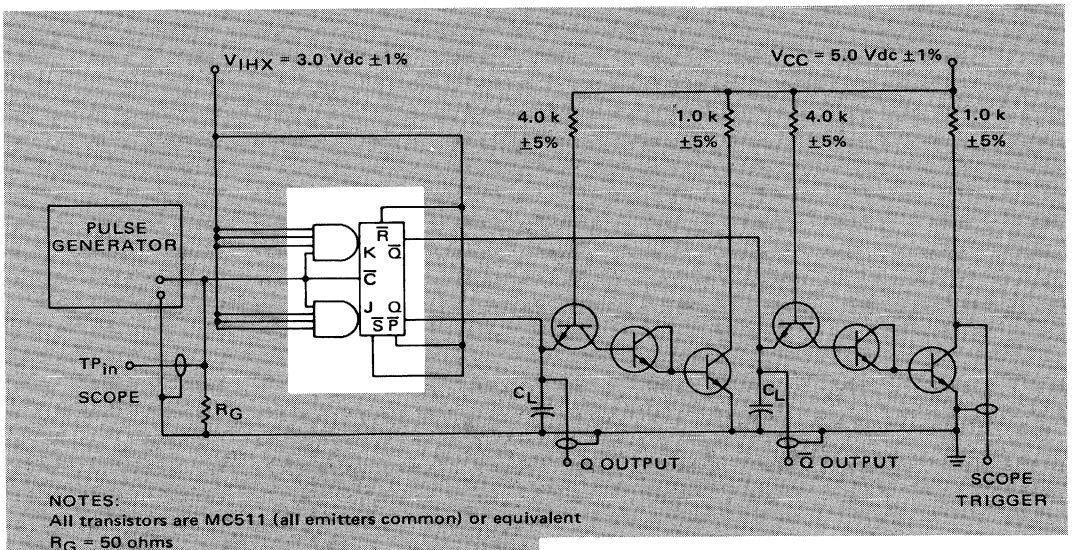
Provides direct $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ inputs. The application of a "0" state to 8 or 9, sets Q high; "0" state to 13, resets Q low. The clock must be in the low state when these functions are performed.

Data at the J and K inputs must be present before the clock goes to a high state. If the information on the J and K inputs is changed while the clock is in a high state, the flip-flop will require typically 300 ns to recognize a "1" state to "0" state information change on the J and K terminals. The flip-flop will require typically 10 ns to recognize a "0" state to "1" state change.

Negative edge triggering – When the clock goes from the high state to the low state, the information in the temporary storage section is transferred and the Q and $\overline{Q}$ outputs will respond accordingly. While the clock is in a low state, the J and K terminals are inhibited.

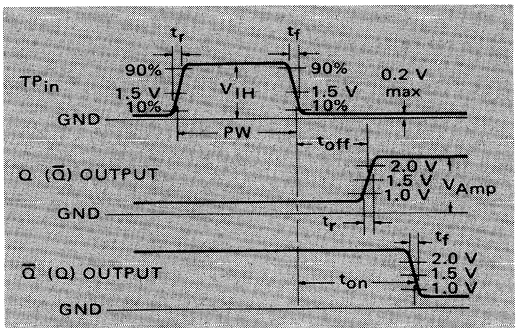
Unused J and K inputs should be tied to the clock or to 2.0 to 5.0 Vdc. $\overline{PRESET}$ and $\overline{SET}$ are tied to $\overline{Q}$; $\overline{RESET}$ is tied to Q.

FIGURE 1 – SWITCHING AND TRIGGER CHARACTERISTICS TEST CIRCUIT



NOTES:
All transistors are MC511 (all emitters common) or equivalent
R_G = 50 ohms
C_L = 15 pF including stray capacitance

VOLTAGE WAVEFORMS AND DEFINITIONS



SWITCHING TIMES

TEST	TEST SYMBOL	INPUT PULSE	MIN	MAX	UNIT
Delay Time Off	t_{off}	V		20	ns
Delay Time On	t_{on}	V		40	ns
Rise Time	t_r	V		8.0	ns
Fall Time	t_f	V		5.0	ns
Amplitude	V_{Amp}	V	3.2		Volt

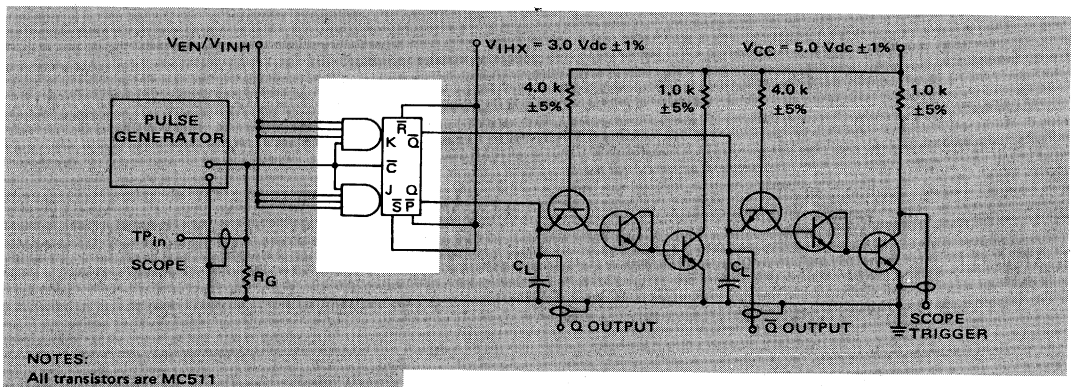
WORST-CASE TESTS
(Device must toggle with each clock pulse)

TEST	SYMBOL	LIMITS	INPUT CONDITIONS
Toggle Frequency	f_{Tog}	20 MHz max	W
Pulse Width	PW	20 ns min	X
Input High Voltage	V_{IH}	1.8 V min	Y
Fall Time	t_f	150 ns max	Z

INPUT PULSE CONDITIONS

SYMBOL	W	V	X	Y	Z	UNIT
PRF	20	5.0	5.0	5.0	1.0	MHz
PW	20	100	20	100	200	ns
t_r	≤10	≤10	≤10	≤10	≤50	ns
t_f	≤10	≤10	≤10	≤10	150	ns
V_{IH}	3.5	3.5	3.5	1.8	3.5	Volt

FIGURE 2 – J-K TERMINAL CHARACTERISTICS TEST CIRCUIT



NOTES:
All transistors are MC511 (all emitters common) or equivalent
R_G = 50 ohms
C_L = 15 pF including stray capacitance

ENABLE MODE TEST:
The device under test shall toggle when V_{EN} = 1.8 Vdc ±1% is applied.

INHIBIT MODE TEST:
The device under test shall NOT toggle when V_{INH} = 1.2 Vdc ±1% is applied.

INPUT VOLTAGE WAVEFORMS AND DEFINITIONS

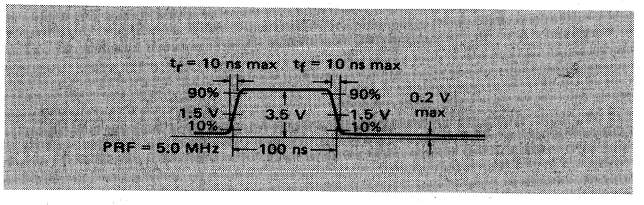
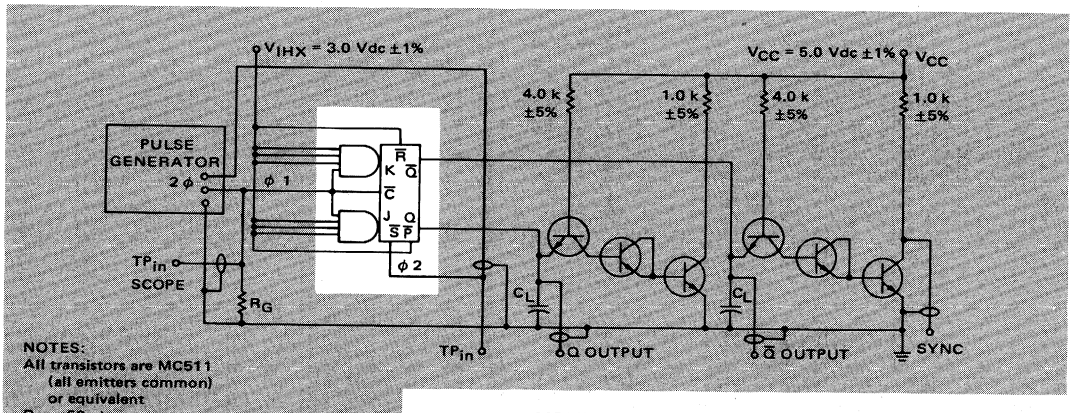


FIGURE 3 – $\overline{\text{SET}}$-$\overline{\text{RESET}}$-$\overline{\text{PRESET}}$ TERMINAL CHARACTERISTICS TEST CIRCUIT



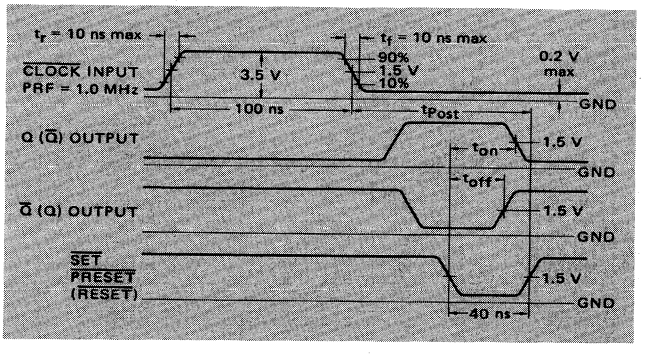
NOTES:
All transistors are MC511 (all emitters common) or equivalent
R_G = 50 ohms
C_L = 15 pF including stray capacitance
t_{Post} = Post Time

TEST PARAMETERS

SYMBOL	VALUE	UNIT
t_{Post}	120	ns min
t_{on}	40	ns max
t_{off}	20	ns max

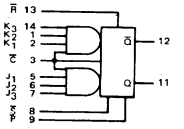
NOTE:
When t_{Post} is 120 ns, $\overline{\text{SET}}$, $\overline{\text{PRESET}}$ or $\overline{\text{RESET}}$ pulses must actuate the device.
$\overline{\text{SET}}$, $\overline{\text{PRESET}}$, and $\overline{\text{RESET}}$ pulse cannot return to the high state before the required post time.
Connections shown for measuring times related to $\overline{\text{SET}}$ terminal only. To measure times at $\overline{\text{PRE-SET}}$ terminal apply input pulse to Pin 9 in place of Pin 8. To measure times at $\overline{\text{RESET}}$ terminals, apply the input pulse to Pin 13.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one J and K input, plus the $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ inputs. To complete testing, sequence through remaining J and K inputs in the same manner.



@ Test Temperature	I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	$2\ I_{in}$ mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	$V_{th\,0}$ Volts	$V_{th\,1}$ Volts	V_{out} Volts	V_{CC} Volts
MC515☆, MC565 −55°C	20	10	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	1.0	2.0	5.5	5.0
MC515☆, MC565 +25°C	20	10	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	1.2	1.7	5.5	5.0
MC515☆, MC565 +125°C	20	10	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	0.9	1.4	5.5	5.0
MC415☆, MC465 0°C	20	10	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.1	1.9	5.5	5.0
MC415☆, MC465 +25°C	20	10	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.2	1.8	5.5	5.0
MC415☆, MC465 +75°C	20	10	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.1	1.7	5.5	5.0

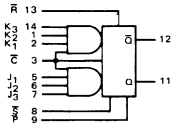
Characteristic	Symbol	Pin Under Test	MC515, MC565 Test Limits −55°C Min	MC515, MC565 Test Limits −55°C Max	MC515, MC565 Test Limits +25°C Min	MC515, MC565 Test Limits +25°C Max	MC515, MC565 Test Limits +125°C Min	MC515, MC565 Test Limits +125°C Max	MC415, MC465 Test Limits 0°C Min	MC415, MC465 Test Limits 0°C Max	MC415, MC465 Test Limits +25°C Min	MC415, MC465 Test Limits +25°C Max	MC415, MC465 Test Limits +75°C Min	MC415, MC465 Test Limits +75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2\ I_{in}$	V_{IL}	V_{IH}	V_R	$V_{th\,0}$	$V_{th\,1}$	V_{out}	V_{CC}	Gnd
Input																											
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	-	2,3,5,6, 7,9,13,14	-	-	-	4	1,8,10
		5	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	1,2,3,6, 7,8,9,14	-	-	-	↓	5,10,13
		8	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	1,2,3,5, 6,7,9,14	-	-	-	↓	8,10,13
		9	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	1,2,3,5, 6,7,8,14	-	-	-	↓	9,10,13
		13	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	1,2,3,5, 6,7,9,14	-	-	-	↓	8,10,13
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	-	1	-	-	-	4	2,3,5,6,7,10,11,14
		5	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	5	-	-	-	↓	1,2,3,6,7,10,12,14
		8	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	8	-	-	-	↓	1,2,3,5,6,7,9,10,12,14
		9	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	9	-	-	-	↓	1,2,3,5,6,7,8,10,12,14
		13	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	13	-	-	-	↓	1,2,3,5,6,7,10,11,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	8	-	1	-	-	-	4	10
		5	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	13	-	5	-	-	-	↓	↓
		8	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	↓	-	8	-	-	-	↓	↓
		9	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	↓	-	9	-	-	-	↓	↓
		13	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	8	-	13	-	-	-	↓	↓
Breakdown Voltage	BV_{in}"0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	8	-	-	-	-	-	4	10
		5	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	5	-	13	-	-	-	-	-	↓	↓
		8	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	8	-	↓	-	-	-	-	-	↓	↓
		9	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	9	-	↓	-	-	-	-	-	↓	↓
		13	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	13	-	8	-	-	-	-	-	↓	↓
	BV_{in}"1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	-	4	2,3,5,6,7,10,11,14
		5	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	5	-	-	-	-	-	-	-	↓	1,2,3,6,7,10,12,14
		8	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	8	-	-	-	-	-	-	-	↓	1,2,3,5,6,7,9,10,12,14
		9	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	9	-	-	-	-	-	-	-	↓	1,2,3,5,6,7,8,10,12,14
		13	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	13	-	-	-	-	-	-	-	↓	1,2,3,5,6,7,10,11,14

* Prime Fan-Out.

(continued)

ELECTRICAL CHARACTERISTICS (continued)

Test procedures are shown for only one J and K input, plus the $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ inputs. To complete testing, sequence through remaining J and K inputs in the same manner.

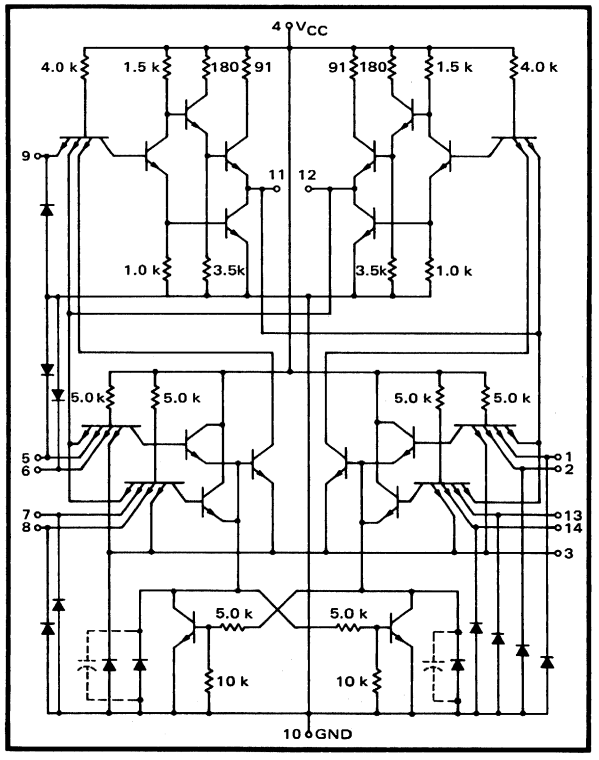


@ Test Temperature		TEST CONDITIONS: mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	$2\ I_{in}$	Volts V_{IL}	V_{IH}	V_R	$V_{th\,0}$	$V_{th\,1}$	V_{out}	V_{CC}
MC515*, MC565	−55°C	20	10	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	1.0	2.0	5.5	5.0
	+25°C	20	10	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	1.2	1.7	5.5	5.0
	+125°C	20	10	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	0.9	1.4	5.5	5.0
MC415*, MC465	0°C	20	10	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.1	1.9	5.5	5.0
	+25°C	20	10	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.2	1.8	5.5	5.0
	+75°C	20	10	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.1	1.7	5.5	5.0

Characteristic	Symbol	Pin Under Test	MC515, MC565 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC415, MC465 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2\ I_{in}$	V_{IL}	V_{IH}	V_R	$V_{th\,0}$	$V_{th\,1}$	V_{out}	V_{CC}	Gnd
Clock Input Forward Current	I_F	3	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	-	-	-	-	1,2,5,6, 7,8,9,13,14	-	-	-	4	3,10
Leakage Current	I_R	3	-	150	-	150	-	150	-	150	-	150	-	150	μAdc	-	-	-	-	-	-	3	-	-	-	4	1,2,5,6,7,10,14
Inverse Beta Current	I_L	3	-	150	-	150	-	150	-	150	-	150	-	150	μAdc	-	-	-	-	13	-	3	-	-	-	4	10
		3	-	150	-	150	-	150	-	150	-	150	-	150	μAdc	-	-	-	-	8	-	3	-	-	-	4	10
Breakdown Voltage	BV_{in} "0"	3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	3	13	-	-	-	-	-	4	10
		3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	3	8	-	-	-	-	-	4	10
	BV_{in} "1"	3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	3	-	-	-	-	-	-	4	1,2,5,6,7,10,14
Output Output Voltage	V_{out} "0"	12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	-	-	13	-	4	3,8,10
		11	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	11	-	-	-	-	-	-	-	9	-	↓	3,10,13
		11	-		-		-		-		-		-			11	-	-	-	-	-	-	-	8	-		3,10,13
	V_{out} "1"	12	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	13	-	-	4	8,10
		11	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	11	-	-	-	-	-	9	-	-	↓	10,13
		11		-		-		-		-		-		-		-	11	-	-	-	-	-	8	-	-		10,13
Leakage Current	I_{OLK}	12	-	225	-	225	-	225	-	225	-	225	-	225	μAdc	-	-	-	-	-	-	-	-	-	12	4	1,2,3,5,6,7,8,9,10,13,14
		11	-	225	-	225	-	225	-	225	-	225	-	225	μAdc	-	-	-	-	-	-	-	-	-	11	4	1,2,3,5,6,7,8,9,10,13,14
Short-Circuit Current	I_{SC}	12	-	-	-45	-90	-	-	-	-	-45	-90	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	1,2,3,5,6,7,8,9,10,12,13,14
		11	-	-	-45	-90	-	-	-	-	-45	-90	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	1,2,3,5,6,7,8,9,10,11,13,14
Output Voltage	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	-	13	-	-	-	-	4	3,8,10
		11	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	11	-	-	-	-	9	-	-	-	-	↓	3,10,13
		11	-		-		-		-		-		-			11	-	-	-	-	8	-	-	-	-		3,10,13
	V_{OH}	12	2.80	-	3.20	-	3.35	-	3.00	-	3.10	-	3.15	-	Vdc	-	12	-	-	13	-	-	-	-	-	4	8,10
		11	↓	-		-	↓	-	↓	-	↓	-	↓	-	↓	-	11	-	-	9	-	-	-	-	-	↓	10,13
		11		-		-		-		-		-		-		-	11	-	-	8	-	-	-	-	-		10,13
Power Requirements (Total Device) Power Supply Drain	I_{PD}	4	-	12	-	12	-	12	-	14	-	14	-	14	mAdc	-	-	-	-	-	-	-	-	-	-	4	3,10,13
	I_{PD}	4	-	12	-	12	-	12	-	14	-	14	-	14	mAdc	-	-	-	-	-	-	-	-	-	-	4	3,8,10

* Prime Fan-Out.

MC516 · MC566
MC416 · MC466

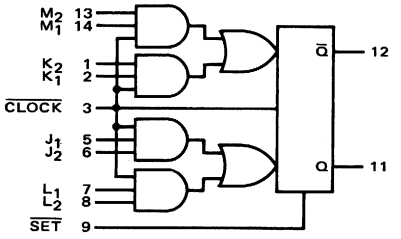


The MC516, MC566, MC416, and MC466 are clocked flip-flops that trigger on the negative edge and are internally wired to perform the J-K logic function. Each flip-flop has a positive logic AND-OR input gating configuration that consists of two clocked J inputs ANDed together, two clocked K inputs ANDed together, two clocked L inputs ANDed together, and two clocked M inputs ANDed together. The J and the L inputs are ORed together and the K and the M inputs are ORed together. A direct $\overline{SET}$ is also available.

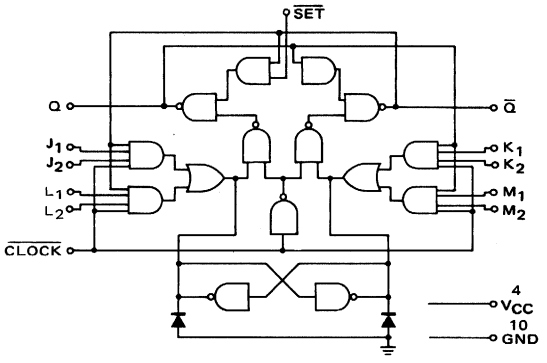
In normal operation, information is changed on the clocked inputs while the clock is in a low state, since the inputs are inhibited in this condition. Information is read into a temporary memory through the AND-OR input gating when the clock is in the high state. When the clock returns low the information in the temporary memory is transferred to the bistable section and the Q and the $\overline{Q}$ outputs respond accordingly. The information on the clocked inputs should not be changed while the clock is high.

Each flip-flop can be set directly by applying a low state to the direct $\overline{SET}$ input. Since each flip-flop is a charge storage device there is a restriction on the clock fall time that must be observed.

The AND-OR input configuration of each flip-flop makes it very useful for shift right/shift left registers and for up/down counters.



EQUIVALENT CIRCUIT



J	L	K	M	Q_n	Q_{n+1}
0	0	X	X	0	0
1	X	X	X	0	1
X	1	X	X	0	1
X	X	0	0	1	1
X	X	1	X	1	0
X	X	X	1	1	0

X = Don't Care
Where $J = J_1 \cdot J_2$
$L = L_1 \cdot L_2$
$K = K_1 \cdot K_2$
$M = M_1 \cdot M_2$

Total Power Dissipation = 60 mW typ/pkg
Switching Times:
t_{on} = 25 ns typ
t_{off} = 13 ns typ

SERIES	INPUT LOADING FACTOR		(I_F)		OUTPUT DRIVE (I_{OL})		TEMPERATURE RANGE
	CLOCK	ALL OTHER	CLOCK	ALL OTHER			
MC516 MC566	3	1	(−4.0 mA)	(−1.33 mA)	15 MC500 series Gates 7 MC500 series Gates	(20 mA) (10 mA)	−55°C to +125°C
MC416 MC466	3	1	(−5.0 mA)	(−1.66 mA)	12 MC400 series Gates 6 MC400 series Gates	(20 mA) (10 mA)	0°C to +75°C

OPERATING CHARACTERISTICS

Clock fall time $\leq$ 150 ns.

Triggers on clock pulse widths $\geq$ 20 ns.

The application of a "0" state to the $\overline{SET}$ will cause Q to go to the "1" state. The clock must be in the low state when this function is performed.

Data at the clocked inputs must be present before the clock goes to a high state. If the information on the clocked inputs is changed while the clock is in a high state, the flip-flop will require typically 300 ns to recognize a "1" state to "0" state change. The flip-flop will also require typically 10 ns to recognize a "0" state to "1" state change.

Negative edge triggering — When the clock goes from the high state, the information in the temporary storage section is transferred; and the Q and $\overline{Q}$ outputs will change accordingly. While the clock is in a low state, the J, K, L, and M terminals are inhibited.

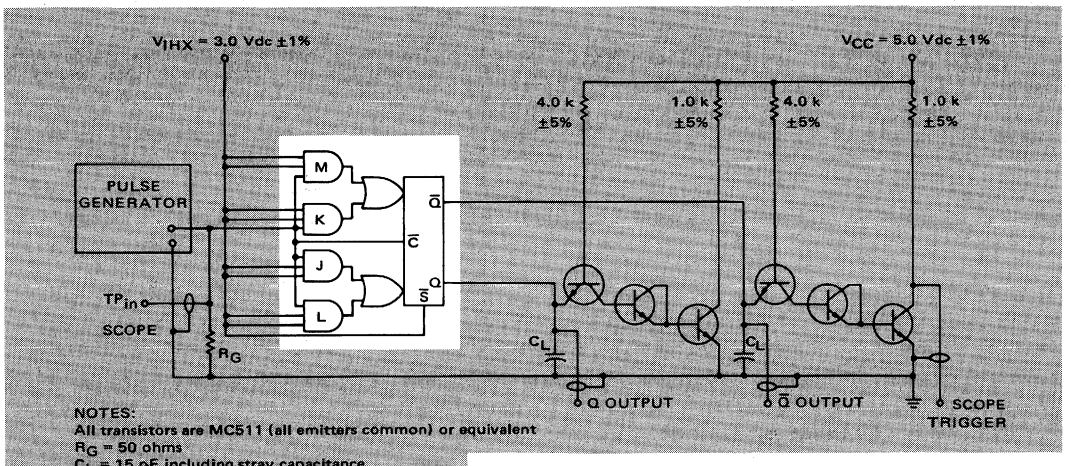
Unused Inputs:

Single unused J, K, L, and M inputs should be tied to the used input, to the clock input, or to 2.0 to 5.0 Vdc.

If both J, K, L, or M inputs are unused, they MUST be tied to ground.

Unused $\overline{SET}$ is tied to $\overline{Q}$.

FIGURE 1 — SWITCHING AND TRIGGER CHARACTERISTICS TEST CIRCUIT



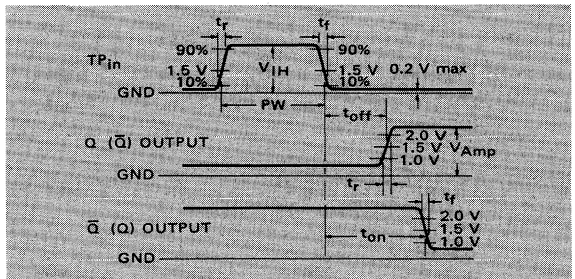
SWITCHING TIMES

TEST	TEST SYMBOL	INPUT PULSE	MIN	MAX	UNIT
Delay Time Off	t_{off}	V		20	ns
Delay Time On	t_{on}	V		40	ns
Rise Time	t_r	V		8.0	ns
Fall Time	t_f	V		5.0	ns
Amplitude	V_{Amp}	V	3.2		Volt

WORST-CASE TESTS
(Device must toggle with each clock pulse)

TEST	SYMBOL	LIMITS	INPUT CONDITIONS
Toggle Frequency	f_{Tog}	20 MHz max	W
Pulse Width	PW	20 ns min	X
Input High Voltage	V_{IH}	1.8 V min	Y
Fall Time	t_f	150 ns max	Z

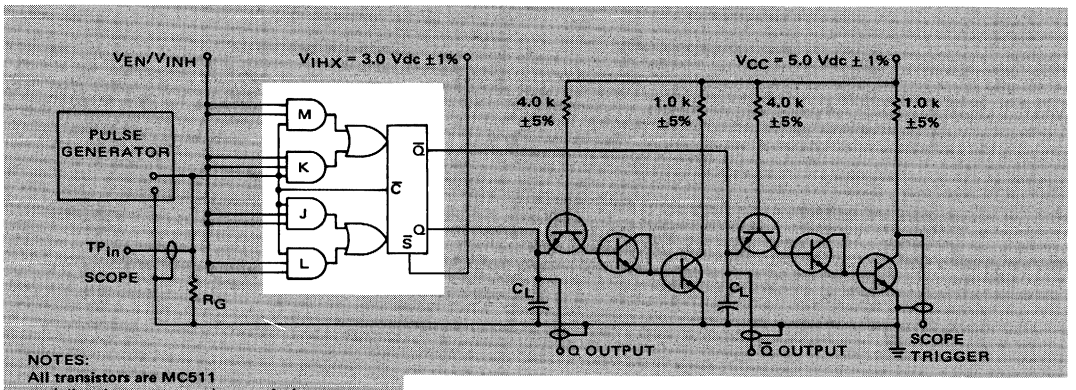
VOLTAGE WAVEFORMS AND DEFINITIONS



INPUT PULSE CONDITIONS

SYMBOL	W	V	X	Y	Z	UNIT
PRF	20	5.0	5.0	5.0	1.0	MHz
PW	20	100	20	100	200	ns
t_r	$\leq$10	$\leq$10	$\leq$10	$\leq$10	$\leq$50	ns
t_f	$\leq$10	$\leq$10	$\leq$10	$\leq$10	150	ns
V_{IH}	3.5	3.5	3.5	1.8	3.5	Volt

FIGURE 2 – J-K-L-M TERMINAL CHARACTERISTICS TEST CIRCUIT



NOTES:
All transistors are MC511 (all emitters common) or equivalent
R_G = 50 ohms
C_L = 15 pF including stray capacitance

ENABLE MODE TEST:
The device under test shall toggle when V_{EN} = 1.8 Vdc ±1% is applied.

INHIBIT MODE TEST:
The device under test shall NOT toggle when V_{INH} = 1.2 Vdc ±1% is applied.

INPUT VOLTAGE WAVEFORMS AND DEFINITIONS

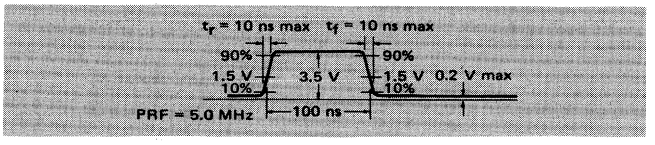
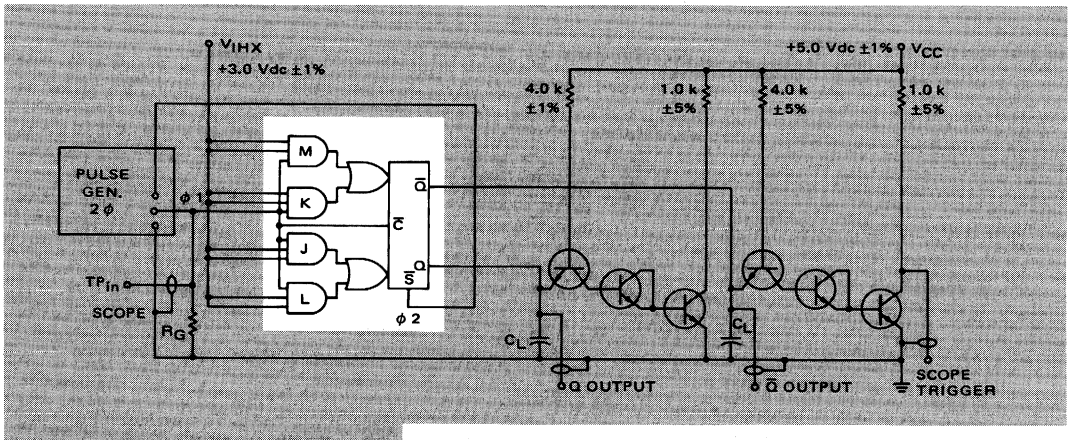


FIGURE 3 – $\overline{SET}$ TERMINAL CHARACTERISTICS TEST CIRCUIT



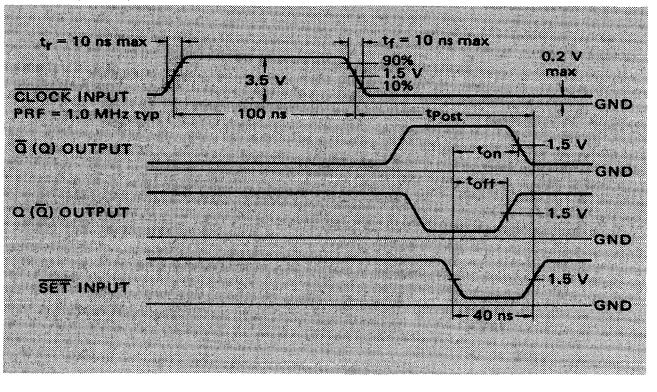
NOTES:
All transistors are MC511 (all emitters common) or equivalent
R_G = 50 ohms
C_L = 15 pF including stray capacitance
t_{Post} = Post Time

TEST PARAMETERS

SYMBOL	VALUE	UNIT
t_{Post}	120	ns min
t_{on}	40	ns max
t_{off}	20	ns max

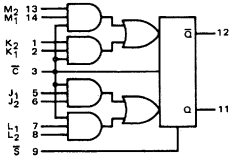
NOTE:
When t_{Post} is 120 ns, $\overline{SET}$ pulse must actuate the device. $\overline{SET}$ pulse cannot return to the high state before the required post time.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one J, one K, and the $\overline{SET}$ input. The remaining J, K, L, M inputs are tested in the same manner.



@ Test Temperature		I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	$2\ I_{in}$ mA	$4\ I_{in}$ mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	$V_{th\,1}$ Volts	$V_{th\,0}$ Volts	V_{out} Volts	V_{CC} Volts
MC516*, MC566	−55°C	20	10	-1.5	-0.7	1.0	2.0	4.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0
	+25°C	20	10	-1.5	-0.7	1.0	2.0	4.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0
	+125°C	20	10	-1.5	-0.7	1.0	2.0	4.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0
MC416*, MC466	0°C	20	10	-1.2	-0.6	1.0	2.0	4.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0
	+25°C	20	10	-1.2	-0.6	1.0	2.0	4.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0
	+75°C	20	10	-1.2	-0.6	1.0	2.0	4.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0

Characteristic	Symbol	Pin Under Test	MC516, MC566 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC416, MC466 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2\ I_{in}$	$4\ I_{in}$	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	Gnd
Input																												
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	-	-	2,3,5,6,7, 8,13,14	-	-	-	4	1,9,10
		5	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	1,2,3,6,7, 8,13,14	-	-	-	↓	5,10,11
		9	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	1,2,5,6,7, 8,13,14	-	-	-	↓	3,9,10,11
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	-	-	1	-	-	-	4	2,3,5,6,7,8,10,11,13,14
		5	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	5	-	-	-	↓	1,2,3,6,7,8,9,10,12,13,14
		9	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	9	-	-	-	↓	1,2,3,5,6,7,8,10,12,13,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	-	-	1	-	-	-	4	9,10
		5	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	5	-	-	-	↓	10,11
		9	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	9	-	-	-	↓	10,11
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	-	-	4	9,10
		5	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	5	-	-	-	-	-	-	-	-	↓	10,11
		9	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	9	-	-	-	-	-	-	-	-	↓	10,11
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	-	-	4	2,3,5,6,7,8,10,11,13,14
		5	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	5	-	-	-	-	-	-	-	-	↓	1,2,3,6,7,8,9,10,12,13,14
		9	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	9	-	-	-	-	-	-	-	-	↓	1,2,3,5,6,7,8,10,12,13,14

* Prime Fan-Out

① Momentarily ground pin prior to taking measurement at terminal.

ELECTRICAL CHARACTERISTICS (continued)

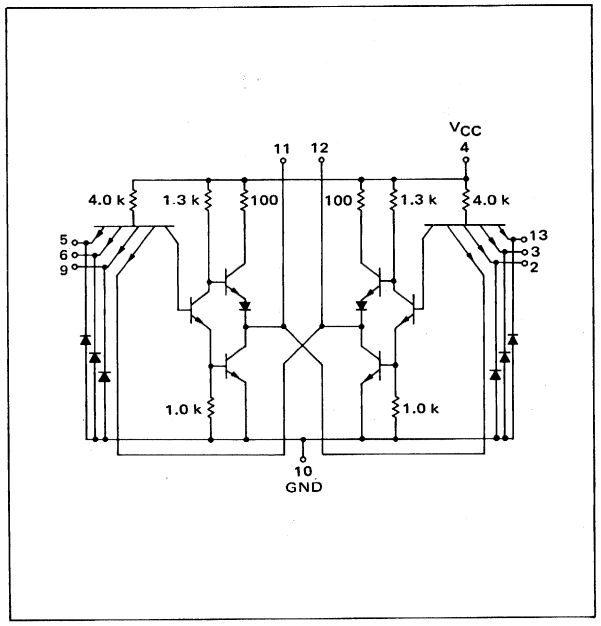
@ Test Temperature		TEST CONDITIONS mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	mA I_{in}	mA $2\,I_{in}$	mA $4\,I_{in}$	Volts V_{IL}	Volts V_{IH}	Volts V_R	Volts $V_{th\,1}$	Volts $V_{th\,0}$*	Volts V_{out}	Volts V_{CC}
MC516☆, MC566	−55°C	20	10	-1.5	-0.7	1.0	2.0	4.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0
	+25°C	20	10	-1.5	-0.7	1.0	2.0	4.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0
	+125°C	20	10	-1.5	-0.7	1.0	2.0	4.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0
MC416☆, MC466	0°C	20	10	-1.2	-0.6	1.0	2.0	4.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0
	+25°C	20	10	-1.2	-0.6	1.0	2.0	4.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0
	+75°C	20	10	-1.2	-0.6	1.0	2.0	4.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0

Characteristic	Symbol	Pin Under Test	MC516, MC566 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC416, MC466 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2\,I_{in}$	$4\,I_{in}$	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	Gnd
Clock Input Forward Current	I_F	3	-	-4.0	-	-4.0	-	-4.0	-	-5.0	-	-5.0	-	-5.0	mAdc	-	-	-	-	-	-	-	1,2,5,6,7, 8,13,14	-	-	-	4	3,10
Leakage Current	I_R	3	-	300	-	300	-	300	-	300	-	300	-	300	μAdc	-	-	-	-	-	-	-	3	-	-	-	4	1,2,5,6,7,8,10,13,14
Inverse Beta Current	I_L	3	-	400	-	400	-	400	-	400	-	400	-	400	mAdc	-	-	-	-	-	-	-	3	-	-	-	4	9,10
		3	-	400	-	400	-	400	-	400	-	400	-	400	mAdc	-	-	-	-	-	-	-	3	-	-	-	4	10,11
Breakdown Voltage	BV_{in} "0"	3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	-	3	-	-	-	-	-	-	4	10, 11
		3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	-	3	-	-	-	-	-	-	4	9,10
	BV_{in} "1"	3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	3	-	-	-	-	-	-	-	4	1,2,5,6,7,8,10,13,14
Output (For Set Only) Output Voltage	V_{out} "0"	11	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	11①	-	-	-	-	-	-	-	9	-	-	4	3, 10
	V_{out} "1"	11	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	11	-	-	-	-	-	-	-	9	-	4	3,10
Leakage Current	I_{OLK}	12	-	650	-	650	-	650	-	650	-	650	-	650	μAdc	-	-	-	-	-	-	-	12	-	-	-	4	1,2,3,5,6,7,8,10,11,13,14
		11	-	650	-	650	-	650	-	650	-	650	-	650	μAdc	-	-	-	-	-	-	-	11	-	-	-	4	1,2,3,5,6,7,8,9,10,13,14
Short-Circuit Current	I_{SC}	12	-	-	-45	-90	-	-	-	-	-45	-90	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	1,2,3,5,6,7,8,10,11,12,13,14
		11	-	-	-45	-90	-	-	-	-	-45	-90	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	1,2,3,5,6,7,8,9,10,11,13,14
Output Voltage	V_{OH}	12	2.80	-	3.20	-	3.35	-	3.00	-	3.10	-	3.15	-	Vdc	-	12	-	-	-	-	-	-	-	-	-	4	3,10,11
		11	2.80	-	3.20	-	3.35	-	3.00	-	3.10	-	3.15	-	Vdc	-	11	-	-	-	-	-	-	-	-	-	4	3,10,12
	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12①	-	-	-	-	-	9	-	-	-	-	4	3,10
		11	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	11①	-	-	-	-	-	9	-	-	-	-	4	3,10
Breakdown Voltage	I_O	12	-	4.25	-	4.25	-	4.25	-	4.25	-	4.25	-	4.25	mAdc	-	-	-	-	-	-	-	-	-	-	12	4	1,2,3,5,6,7,8,10,11,13,14
		11	-	4.25	-	4.25	-	4.25	-	4.25	-	4.25	-	4.25	mAdc	-	-	-	-	-	-	-	-	-	-	11	4	1,2,3,5,6,7,8,9,10,13,14
Power Requirements (Total Device) Power Supply Drain	I_{PD}	4	-	12	-	12	-	12	-	14	-	14	-	14	Vdc	-	-	-	-	-	-	-	-	-	-	-	4	3,10,12
	I_{PD}	4	-	12	-	12	-	12	-	14	-	14	-	14	Vdc	-	-	-	-	-	-	-	-	-	-	-	4	3,10,11

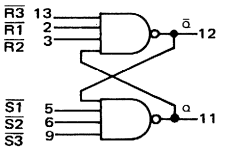
* Prime Fan-Out

① Momentarily ground pin prior to taking measurement at terminal.

MC513 · MC563
MC413 · MC463



This device consists of two independent dual 4-input NAND gates, internally cross coupled to realize a multiple input R-S flip-flop. The circuit can be used to eliminate switch contact bounce and to provide a temporary storage for data.



$\overline{R} = 2 \cdot 3 \cdot 13$

$\overline{S} = 5 \cdot 6 \cdot 9$

Positive Logic =

$11 = Q = \overline{5} + \overline{6} + \overline{9} + \overline{12}$

Total Power Dissipation = 30 mW typ/pkg

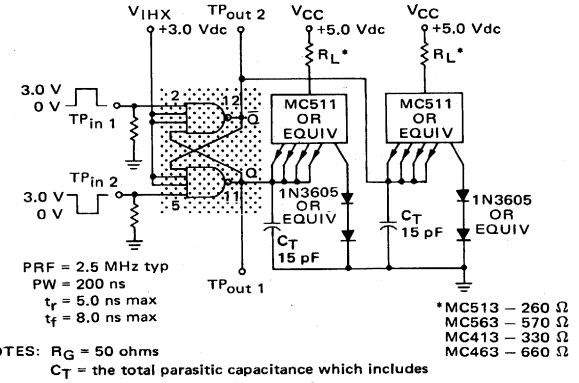
Propagation Delay Time = 20 ns typ (to change state)

TRUTH TABLE (Positive Logic)

$\overline{R}$	$\overline{S}$	Q	$\overline{Q}$
0	0	Not Permitted	
0	1	0	1
1	0	1	0
1	1	Q	$\overline{Q}$

SERIES	INPUT LOADING FACTOR (I_F)	OUTPUT DRIVE (I_{OL})	TEMPERATURE RANGE
MC513 MC563	1 (-1.33 mA)	15 MC500 series Gates (20 mA) 7 MC500 series Gates (10 mA)	−55°C to +125°C
MC413 MC463	1 (-1.66 mA)	12 MC400 series Gates (20 mA) 6 MC400 series Gates (10 mA)	0°C to +75°C

SWITCHING TIME TEST CIRCUIT †



NOTES: R_G = 50 ohms

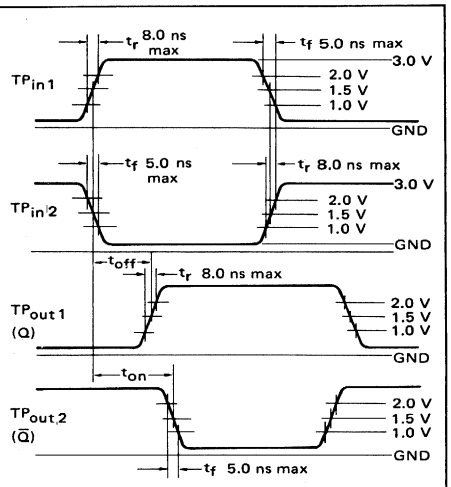
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.

Scope rise time < 1.0 ns

Probe capacitance < 5.0 pF

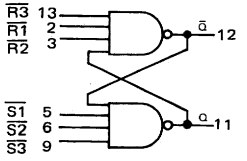
† To measure t_{on}, t_f for Q and t_{off}, t_r for $\overline{Q}$, reverse input polarities.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input. The other inputs are tested in the same manner.



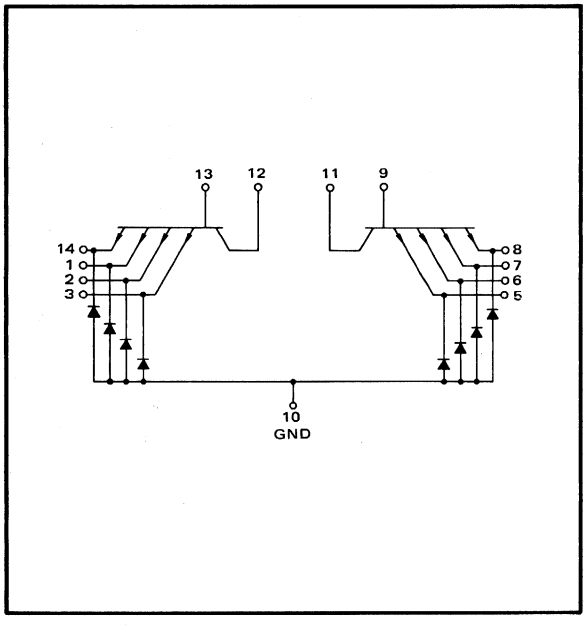
@ Test Temperature		TEST CONDITIONS mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	Volts V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}
MC513*, MC563	−55°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0
	+25°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0
	+125°C	20	10	-1.5	-0.7	1.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0
MC413*, MC463	0°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0
	+25°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0
	+75°C	20	10	-1.2	-0.6	1.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0

Characteristic	Symbol	Pin Under Test	MC513, MC563 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC413, MC463 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	Gnd
Input																										
Forward Current	I_F	2	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	3,13	-	-	-	4	2,10
		5	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	6,9	-	-	-	4	5,10
Leakage Current	I_R	2	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	2	-	-	-	4	3,10,13
		5	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	5	-	-	-	4	6,9,10
Inverse Beta Current	I_L	2	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	2	-	-	-	4	5,6,9,10
		5	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	5	-	-	-	4	2,3,10,13
Breakdown Voltage	BV_{in}"0"	2	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	2	-	-	-	-	-	-	4	5,6,9,10
		5	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	5	-	-	-	-	-	-	4	2,3,10,13
	BV_{in}"1"	2	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	2	-	-	-	-	-	-	4	3,10,13
		5	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	5	-	-	-	-	-	-	4	6,9,10
Output																										
Output Voltage	V_{out} "0"	11	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	11	-	-	-	-	-	5	-	-	4	2,3,10,13
	V_{out} "1"	11	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	11	-	-	-	-	-	5	-	4	2,3,10,13
Leakage Current	I_{OLK}	11	-	1.25	-	1.25	-	1.25	-	1.25	-	1.25	-	1.25	mAdc	-	-	-	-	-	-	-	-	11	4	5,6,9,10
Short-Circuit Current	I_{SC}	11	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	-10	-45	mAdc	-	-	-	-	-	-	-	-	-	4	5,6,9,10,11
Output Voltage	V_{OH}	11	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	11	-	5	-	-	-	-	-	4	2,3,10,13
	V_{OL}	11	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	11	-	-	-	5	-	-	-	-	4	2,3,10,13
Power Requirements (Total Device)																										
Power Supply Crain	I_{PD}	4	-	-	-	9.0	-	-	-	-	-	9.0	-	-	mAdc	-	-	-	-	-	-	-	-	-	4	5,6,9,10
		4	-	-	-	9.0	-	-	-	-	-	9.0	-	-	mAdc	-	-	-	-	-	-	-	-	-	4	2,3,10,13
Switching Parameters																Pulse In	Pulse Out									
Turn-On Delay	t_{on} ‡	2, 12	-	-	-	30	-	-	-	-	-	30	-	-	ns	2, 5	12	-	-	-	-	-	-	-	4	10
Turn-Off Delay	t_{off} ‡	2, 11	-	-	-	20	-	-	-	-	-	20	-	-	ns	2, 5	11	-	-	-	-	-	-	-	4	10
Rise Time	t_r ‡	2, 11	-	-	-	8.0	-	-	-	-	-	8.0	-	-	ns	2, 5	11	-	-	-	-	-	-	-	4	10
Fall Time	t_f ‡	2, 12	-	-	-	5.0	-	-	-	-	-	5.0	-	-	ns	2, 5	12	-	-	-	-	-	-	-	4	10

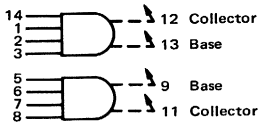
* Prime Fan-Out

‡ To measure t_{on}, t_f for Q and t_{off}, t_r for $\overline{Q}$, reverse input polarities.

MC511 · MC561
MC411 · MC461



This device consists of two independent 4-emitter input transistors, each of which performs the positive logic AND function when used in conjunction with expandable gates. The base and collector of each device is available for expansion. Using the MC511 with the MC506 expandable gate, the number of AND inputs can be expanded to 20.



Total Power Dissipation = 0 mW typ/pkg

Propagation Delay Time:

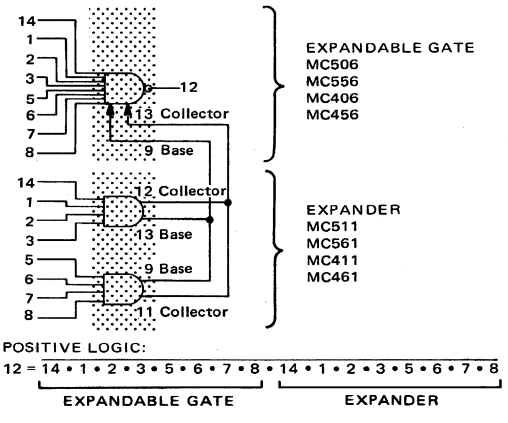
Δt_{pd} = +3.0 ns typ
When added to the expandable "AND-OR-INVERT" gate.

$\Delta t_{pd}/pF$ = +1.6 ns/pF typ
Caused by additional capacitance at expander points.

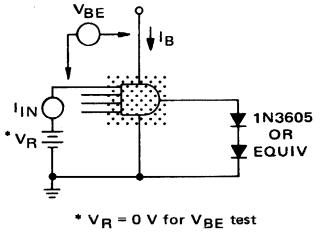
SERIES	INPUT LOADING FACTOR (I_F)	TEMPERATURE RANGE
MC511 MC561	1 (−1.33 mA)	−55°C to +125°C
MC411 MC461	1 (−1.66 mA)	0°C to +75°C

Full output loading factor of the expandable gate is maintained.

APPLICATION: EXPANDABLE 8-INPUT "AND-OR-INVERT" GATE WITH A DUAL 4-INPUT EXPANDER CONNECTED.



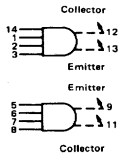
BV_{in} "0", V_{BE}, I_L TEST CIRCUIT



* V_R = 0 V for V_{BE} test

ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one expander. The other expander is tested in a similar manner. Further, test procedures are shown for only one input of the expander being tested. To complete testing, sequence through remaining inputs.



@ Test Temperature		TEST CONDITIONS mA I_{B1}	I_{B2}	I_{in}	Volts V_R	V_{DC}	V_C
MC511, MC561	−55°C	1.33	1.0	1.0	4.5	**	1.5
	+25°C	1.33	1.0	1.0	4.5	**	1.5
	+125°C	1.33	1.0	1.0	4.5	**	1.5
MC411, MC461	0°C	1.66	1.0	1.0	4.5	**	1.5
	+25°C	1.66	1.0	1.0	4.5	**	1.5
	+75°C	1.66	1.0	1.0	4.5	**	1.5

Characteristic	Symbol	Pin Under Test	MC511, MC561 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC411, MC461 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{B1}	I_{B2}	I_{in}	V_R	V_{DC}	V_C	Gnd†
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	13	-	-	1	-	-	2,3,10,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	13	-	1	12	-	10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	13	1	-	12	-	10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	13	-	1	-	-	-	2,3,10,14
Base-Emitter Voltage	V_{BE}	13, 1	-	1.3	-	1.1	-	1.0	-	1.3	-	1.2	-	1.1	Vdc	13	-	-	-	12	-	1,10
Base-Collector Voltage	V_{BC}	13, 12	-	1.3	-	1.1	-	1.0	-	1.3	-	1.2	-	1.1	Vdc	-	13	-	-	-	-	10,12
Offset Voltage	V_O	12*	-	0.2	-	0.2	-	0.2	-	0.2	-	0.2	-	0.2	Vdc	13	-	-	-	-	-	1,10
Forward Beta	h_{FE}	12	3.0	-	3.0	-	3.0	-	3.0	-	3.0	-	3.0	-	-	13	-	-	-	-	12‡	1,10

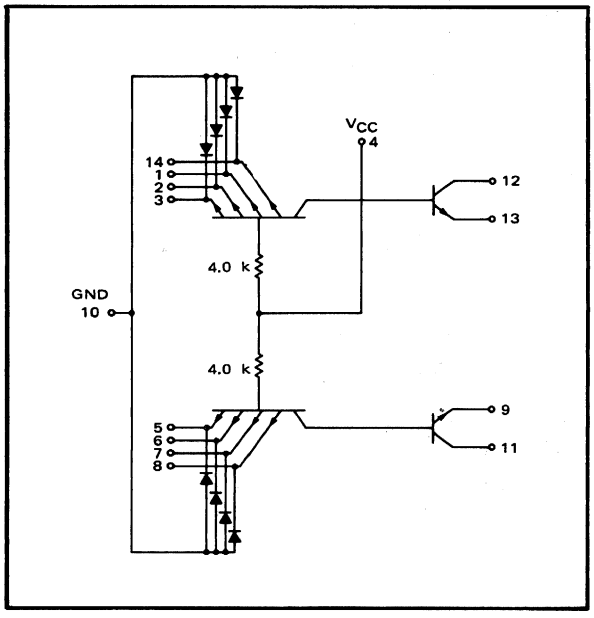
† Ground inputs to expanders not under tests during ALL tests

* Measure V_O from Pin 12 to gnd

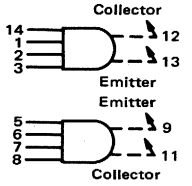
** Voltage obtained with two series diodes tied from collector to gnd.

‡ Measure I_C and calculate Beta. $\left(h_{FE} = \frac{I_C}{I_B}\right)$

MC510 · MC560
MC410 · MC460



This device consists of two independent 4-input AND gates. The outputs of each gate are made available as ORing nodes. Using the MC509 series and the MC510 series with any one of the basic expandable gates, up to 10 AND gates can be ORed together.



Total Power Dissipation = 10 mW typ/Pkg.

Propagation Delay Time:

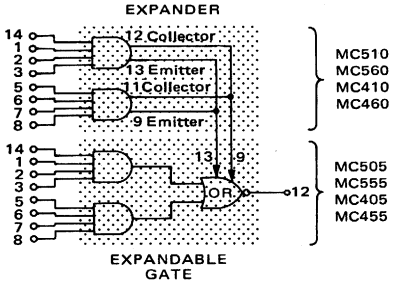
Δt_{pd} = +1.0 ns typ
When added to the expandable "AND-OR-INVERT" gate.

$\Delta t_{pd}/pF$ = +1.0 ns/pF typ
Caused by additional capacitance at expansion points.

SERIES	INPUT LOADING FACTOR (I_F)	TEMPERATURE RANGE
MC510 MC560	1 (−1.33 mA)	−55°C to +125°C
MC410 MC460	1 (−1.66 mA)	0°C to +75°C

Full output loading factor of the expandable gate is maintained.

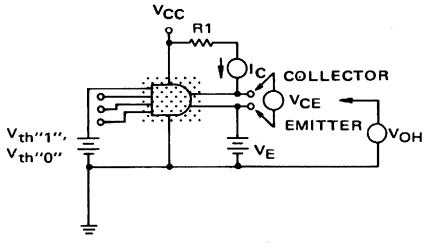
APPLICATION: EXPANDABLE 2-WIDE 4-INPUT, "AND-OR-INVERT" GATE WITH A DUAL 4-INPUT EXPANDER CONNECTED.



POSITIVE LOGIC

$$12 = \underbrace{\overline{(14 \cdot 1 \cdot 2 \cdot 3) + (5 \cdot 6 \cdot 7 \cdot 8)}}_{\text{EXPANDABLE GATE}} + \underbrace{(5 \cdot 6 \cdot 7 \cdot 8) + (14 \cdot 1 \cdot 2 \cdot 3)}_{\text{EXPANDER}}$$

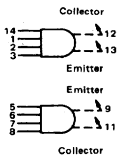
V_{CE}, V_{OH} TEST CIRCUIT



R1 = 1.3 k ohms for V_{OH} test. Adjustable to obtain I_C on V_{CE} test.

ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one expander. The other expander is tested in a similar manner. Further, test procedures are shown for only one input of the expander being tested. To complete testing, sequence through remaining inputs.



@ Test Temperature		TEST CONDITIONS mA I_C	I_{in}	Volts V_R	V_{E1}	V_{E2}	V_{E3}	V_{th1}	V_{th0}	V_{out}	V_{CR}	V_{CRH}	V_{CC}	V_{CCH}
MC510, MC560	−55°C	4.0	1.0	4.5	1.00	0.90	0.8	2.0	1.0	5.5	*	-	5.0	-
	+25°C	4.0	1.0	4.5	0.85	0.75	0.8	1.7	1.2	5.5	*	**	5.0	8.0
	+125°C	4.0	1.0	4.5	0.65	0.55	0.8	1.4	0.9	5.5	*	-	5.0	-
MC410, MC460	0°C	4.0	1.0	4.5	0.90	0.80	0.8	1.9	1.1	5.5	*	-	5.0	-
	+25°C	4.0	1.0	4.5	0.85	0.75	0.8	1.8	1.2	5.5	*	**	5.0	7.0
	+75°C	4.0	1.0	4.5	0.75	0.65	0.8	1.7	1.1	5.5	*	-	5.0	-

Characteristic	Symbol	Pin Under Test	MC510, MC560 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC410, MC460 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_C	I_{in}	V_R	V_{E1}	V_{E2}	V_{E3}	V_{th1}	V_{th0}	V_{out}	V_{CR}	V_{CRH}	V_{CC}	V_{CCH}	Gnd†
Input																												
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	2,3,14	-	-	-	-	-	-	-	-	4	-	1,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	1	-	-	-	-	-	-	-	-	4	-	2,3,10,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	1	13	-	-	-	-	-	12	-	4	-	10
Breakdown Voltage	BV_{in}"0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	1	-	13	-	-	-	-	-	12	-	4	-	10
	BV_{in}"1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	1	-	-	-	-	-	-	-	-	-	4	-	2,3,10,14
Output																												
Output Voltage	V_{OH}	12	4.8	-	4.8	-	4.8	-	4.8	-	4.8	-	4.8	-	Vdc	-	-	-	-	13	-	-	1	-	12	-	4	-	10
	V_{CE} ①	12	-	0.65	-	0.65	-	0.65	-	0.65	-	0.65	-	0.65	Vdc	12	-	-	13	-	-	1	-	-	-	-	4	-	10
Leakage Current	I_{OLK}	12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	13	-	-	12	-	-	4	-	1,2,3,10,14
Power Requirements (Total Device)																												
Maximum Power Supply Current	I_{max} ②	4	-	-	-	10	-	-	-	-	-	10	-	-	mAdc	-	-	-	-	-	9,13	-	-	-	-	11, 12	-	4	1,2,3,10,14
Power Supply Drain	I_{PDH}	4	-	2.5	-	2.5	-	2.5	-	3.0	-	3.0	-	3.0	mAdc	-	-	-	-	-	9,13	-	-	-	-	-	4	-	10‡
	I_{PDL}	4	-	3.0	-	3.0	-	3.0	-	3.5	-	3.5	-	3.5	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3,10,14

* Indicated pins tied to V_{CC} thru 1.3 k ohms ± 1.0% resistor.

** Indicated pins tied to V_{CCH} thru 1.3 k ohms ± 1.0% resistor.

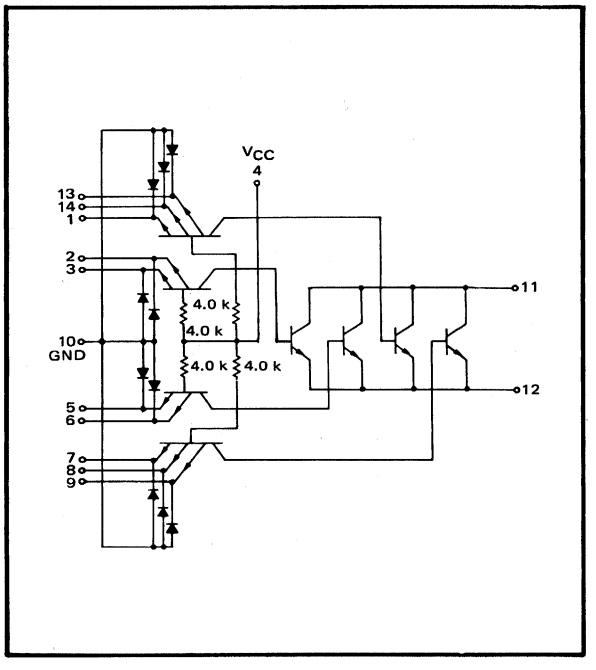
† Ground inputs to gate not under test during ALL tests, unless otherwise noted.

‡ The inputs of both gates must be ungrounded.

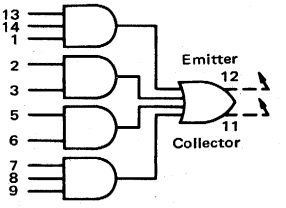
① V_{CE} is referenced to the emitter voltage (Pin 13). The other gate is referenced to (Pin 9).

② Pin 9 ties to Pin 13. Pin 12 ties to Pin 11.

MC509 · MC559
MC409 · MC459



This device consists of two 2-input and two 3-input AND gates ORed together with the common ORing nodes made available as the output. The basic expandable gate can be expanded up to 10 AND gates by using the MC509 series or the MC510 series expander package.



Total Power Dissipation = 20 mW/pkg.

Propagation Delay Time:

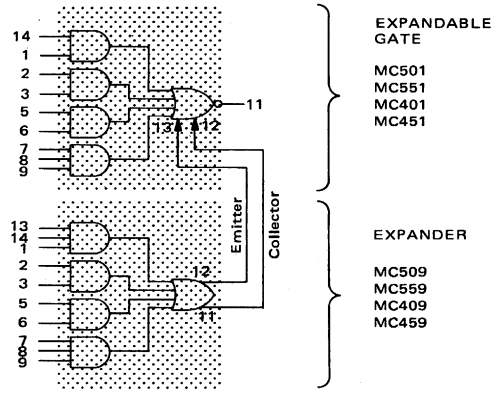
Δt_{pd} = +4.0 ns typ (1.0 ns per ORed function) When added to the expandable "AND-OR-INVERT" gate.

$\Delta t_{pd}/pF$ = 1.0 ns/pF typ Caused by additional capacitance at expansion points.

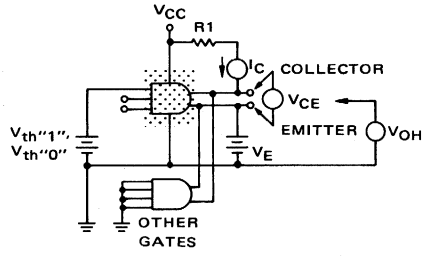
SERIES	INPUT LOADING FACTOR (I_F)	TEMPERATURE RANGE
MC509 MC559	1 (−1.33 mA)	−55°C to +125°C
MC409 MC459	1 (−1.66 mA)	0°C to +75°C

Full output loading factor of the expandable gate is maintained.

APPLICATION: EXPANDABLE 4-WIDE "AND-OR-INVERT" GATE WITH A 4-WIDE 3-2-2-3 INPUT EXPANDER CONNECTED.



V_{CE}, V_{OH} TEST CIRCUIT



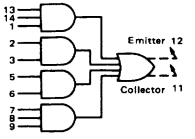
R1 = 1.3 k ohms for V_{OH} test. Adjustable to obtain I_C on V_{CE} test.

POSITIVE LOGIC:

$12 = \underbrace{(14 \cdot 1) + (2 \cdot 3) + (5 \cdot 6) + (7 \cdot 8 \cdot 9)}_{\text{EXPANDABLE GATE}} + \underbrace{(13 \cdot 14 \cdot 1) + (2 \cdot 3) + (5 \cdot 6) + (7 \cdot 8 \cdot 9)}_{\text{EXPANDER}}$

ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input of the device. To complete testing, sequence through remaining inputs in the same manner.

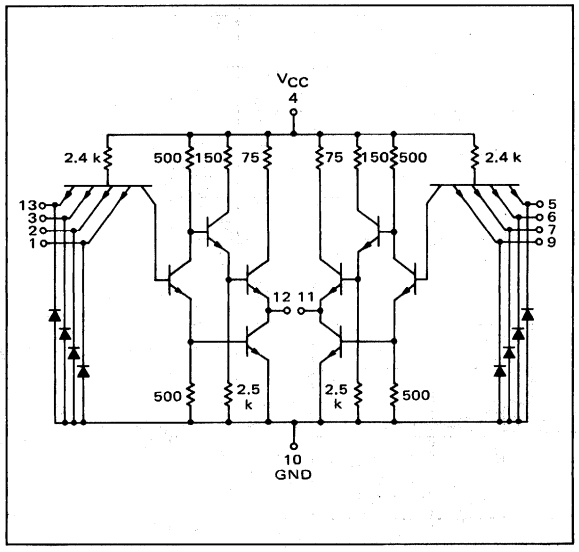


@ Test Temperature	TEST CONDITIONS mA I_C	I_{in}	Volts V_R	V_{E1}	V_{E2}	V_{E3}	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CR}	V_{CRH}	V_{CC}	V_{CCH}
MC509, MC559 −55°C	4.0	1.0	4.5	1.00	0.90	0.8	2.0	1.0	5.5	*	-	5.0	-
MC509, MC559 +25°C	4.0	1.0	4.5	0.85	0.75	0.8	1.7	1.2	5.5	*	**	5.0	8.0
MC509, MC559 +125°C	4.0	1.0	4.5	0.65	0.55	0.8	1.4	0.9	5.5	*	-	5.0	-
MC409, MC459 0°C	4.0	1.0	4.5	0.90	0.80	0.8	1.9	1.1	5.5	*	-	5.0	-
MC409, MC459 +25°C	4.0	1.0	4.5	0.85	0.75	0.8	1.8	1.2	5.5	*	**	5.0	7.0
MC409, MC459 +75°C	4.0	1.0	4.5	0.75	0.65	0.8	1.7	1.1	5.5	*	-	5.0	-

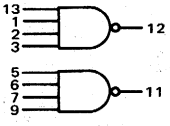
Characteristic	Symbol	Pin Under Test	MC509, MC559 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC409, MC459 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_C	I_{in}	V_R	V_{E1}	V_{E2}	V_{E3}	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CR}	V_{CRH}	V_{CC}	V_{CCH}	Gnd
Input																												
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	2,3,5,6,7, 8,9,13,14	-	-	-	-	-	-	-	-	4	-	1,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	1	-	-	-	-	-	-	-	-	4	-	2,3,5,6,7,8, 9,10,13,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	1	12	-	-	-	-	-	11	-	4	-	2,3,5,6,7,8,9,10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	1	-	12	-	-	-	-	-	11	-	4	-	2,3,5,6,7,8,9,10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	1	-	-	-	-	-	-	-	-	-	4	-	2,3,5,6,7,8,9, 10,13,14
Output																												
Output Voltage	V_{OH}	11	4.8	-	4.8	-	4.8	-	4.8	-	4.8	-	4.8	-	Vdc	-	-	-	-	12	-	-	1	-	11	-	4	-	2,3,5,6,7,8,9,10
	V_{CE} ①	11	-	0.65	-	0.65	-	0.65	-	0.65	-	0.65	-	0.65	Vdc	11	-	-	12	-	-	1	-	-	-	-	4	-	2,3,5,6,7,8,9,10
Leakage Current	I_{OLK}	11	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	12	-	-	11	-	-	4	-	1,2,3,5,6,7,8, 9,10,13,14
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	20	-	-	-	-	-	20	-	-	mAdc	-	-	-	-	-	12	-	-	-	-	11	-	4	1,2,3,5,6,7,8, 9,10,13,14
Power Supply Drain	I_{PDH}	4	-	5.0	-	5.0	-	5.0	-	6.0	-	6.0	-	6.0	mAdc	-	-	-	-	-	12	-	-	-	-	-	4	-	10
	I_{PDL}	4	-	6.0	-	6.0	-	6.0	-	7.0	-	7.0	-	7.0	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3,5,6,7,8, 9,10,13,14

* Indicated pins tied to V_{CC} thru 1.3 kohms ± 1.0% resistor.
** Indicated pins tied to V_{CCH} thru 1.3 kohms ± 1.0% resistor.
① V_{CE} is referenced to the emitter Voltage (Pin 12).

MC507 • MC557
MC407 • MC457



Each of the two independent drivers in the package consists of a 4-input AND gate driving an output inverter. The output inverter is capable of supplying twice the drive of the basic gates. The line driver is especially useful for driving high capacitive loads or for driving large fan-outs such as the numerous clock inputs of large counters.



Positive Logic:
$12 = \overline{1 \cdot 2 \cdot 3 \cdot 13}$

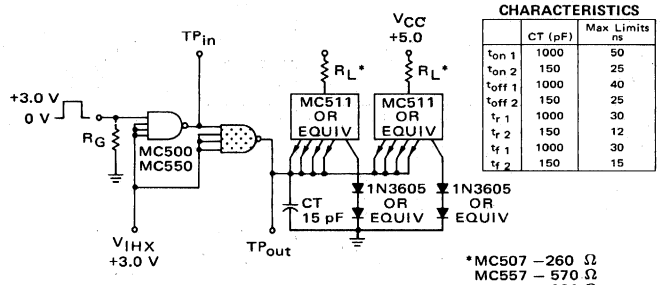
Negative Logic:
$12 = \overline{1 + 2 + 3 + 13}$

Total Power Dissipation = 60 mW typ/pkg
Propagation Delay Time = 25 ns typ @ 1000 pF Load

SERIES	INPUT LOADING FACTOR (I_F)	OUTPUT DRIVE (I_{OL})	TEMPERATURE RANGE
MC507 MC557	1.5 (−2.0 mA)*	30 MC500 series Gates (40 mA) 15 MC500 series Gates (20 mA)	−55°C to +125°C
MC407 MC457	1.5 (−2.5 mA)*	24 MC400 series Gates (40 mA) 12 MC400 series Gates (20 mA)	0°C to +75°C

*Use I_F value of gate being driven (−1.33 or −1.66) to calculate output drive capability of line driver.

SWITCHING TIME TEST CIRCUIT



SWITCHING CHARACTERISTICS

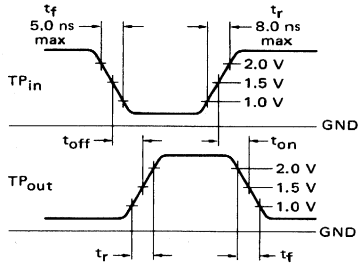
	CT (pF)	Max Limits ns
$t_{on\ 1}$	1000	50
$t_{on\ 2}$	150	25
$t_{off\ 1}$	1000	40
$t_{off\ 2}$	150	25
$t_{r\ 1}$	1000	30
$t_{r\ 2}$	150	12
$t_{f\ 1}$	1000	30
$t_{f\ 2}$	150	15

*MC507 −260 Ω
MC557 − 570 Ω
MC407 − 330 Ω
MC457 − 660 Ω

PRF = 1.0 MHz typ
PW = 200 ns
t_r = 5.0 ns max
t_f = 5.0 ns max

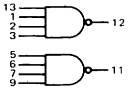
NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Ground inputs to all gates not under test.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one device. The other device is tested in the same manner. Further, test procedures are shown for only one input of the device under test. To complete testing, sequence through remaining inputs.



@ Test Temperature		TEST CONDITIONS mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	Volts V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	$V_{out\,1}$	$V_{out\,2}$	V_{OL}	V_{CC}	V_{CCH}	V_{IHX}
MC507*, MC557	−55°C	40	20	-3.0	-1.5	1.0	0.45	2.8	4.5	2.0	1.0	5.5	-	-	5.0	-	-
	+25°C	40	20	-3.0	-1.5	1.0	0.45	2.8	4.5	1.7	1.2	5.5	6.5	8.0	5.0	8.0	3.0
	+125°C	40	20	-3.0	-1.5	1.0	0.45	2.8	4.5	1.4	0.9	5.5	-	-	5.0	-	-
MC407*, MC457	0°C	40	20	-2.4	-1.2	1.0	0.45	3.0	4.5	1.9	1.1	5.5	-	-	5.0	-	-
	+25°C	40	20	-2.4	-1.2	1.0	0.45	3.0	4.5	1.8	1.2	5.5	6.5	8.0	5.0	7.0	3.0
	+75°C	40	20	-2.4	-1.2	1.0	0.45	3.0	4.5	1.7	1.1	5.5	-	-	5.0	-	-

Characteristic	Symbol	Pin Under Test	MC507, MC557 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC407, MC457 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	$V_{out\,1}$	$V_{out\,2}$	V_{OL}	V_{CC}	V_{CCH}	V_{IHX}	Gnd†
Input																													
Forward Current	I_F	1	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	-	-	-	2,3,13	-	-	-	-	-	4	-	-	1,10
Input Leakage Current	I_R	1	-	200	-	200	-	200	-	200	-	200	-	200	μAdc	-	-	-	-	-	1	-	-	-	-	-	4	-	-	2,3,10,13
Inverse Beta Current	I_L	1	-	200	-	200	-	200	-	200	-	200	-	200	μAdc	-	-	-	-	-	1	-	-	-	-	-	4	-	-	10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	-	-	4	-	-	10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	-	-	4	-	-	2,3,10,13
Output																													
Output Voltage	V_{out} "0"	12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	1	-	-	-	-	4	-	-	10
	V_{out} "1"	12	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	1	-	-	-	4	-	-	10
Low Current MC507/407	I_{OL}	12	-	-	100	-	-	-	-	-	100	-	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	12	4	-	-	10
MC557/457		12	-	-	60	-	-	-	-	-	60	-	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	12	4	-	-	10
Breakdown Current	I_O	12	-	-	-	1.0	-	-	-	-	-	1.0	-	-	mAdc	-	-	-	-	-	-	-	-	-	12	-	4	-	-	1,2,3,10,13
Leakage Current	I_{OLK}	12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	12	-	-	4	-	-	1,2,3,10,13
Short-Circuit Current	I_{SC}	12	-50	-150	-50	-150	-50	-150	-50	-150	-50	-150	-50	-150	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,10,12,13
Output Voltage	V_{OH}	12	2.8	-	3.2	-	3.35	-	3.0	-	3.1	-	3.15	-	Vdc	-	12	-	1	-	-	-	-	-	-	-	4	-	-	10
	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	1	-	-	-	-	-	-	4	-	-	10
Power Requirements (Total Device)																													
Maximum Power Supply Current	I_{max}	4	-	-	-	15	-	-	-	-	-	15	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	4	-	1,5,10
Power Supply Drain	I_{PDH}	4	-	28	-	28	-	28	-	34	-	34	-	34	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	-	-	10‡
	I_{PDL}	4	-	9	-	9	-	9	-	11	-	11	-	11	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	-	-	1,5,10
Switching Parameters																Pulse In	Pulse Out												
Turn-On Delay	t_{on} ①	1,12	-	-	-	50 ①	-	-	-	-	-	50 ①	-	-	ns	1	12	-	-	-	-	-	-	-	-	-	4	-	2,3,13	10
Turn-Off Delay	t_{off} ①	1,12	-	-	-	40 ①	-	-	-	-	-	40 ①	-	-	ns	1	12	-	-	-	-	-	-	-	-	-	4	-	2,3,13	10
Rise Time	t_r ①	1,12	-	-	-	30 ①	-	-	-	-	-	30 ①	-	-	ns	1	12	-	-	-	-	-	-	-	-	-	4	-	2,3,13	10
Fall Time	t_f ①	1,12	-	-	-	30 ①	-	-	-	-	-	30 ①	-	-	ns	1	12	-	-	-	-	-	-	-	-	-	4	-	2,3,13	10

* Prime Fan-Out.
† Ground inputs to gates not under test during ALL tests, unless otherwise noted.
‡ The inputs to all gates must be ungrounded.
①Values @ 1000 pF load.

MTTL II

INTEGRATED CIRCUITS
MC2100/MC2000 SERIES

MTTL II

INTEGRATED CIRCUITS

INDEX

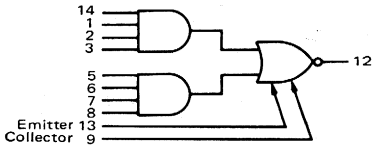
NUMERICAL INDEX
(Functions and Characteristics)

V_{CC} = 5.0 Vdc, T_A = 25°C

Function	Type		Output Loading Factor Each Output		Propagation Delay t_{pd} ns typ	Power Dissipation mW typ/pkg	Page No.
	Case 609, 93 0 to +75°C	Case 609 -55 to +125°C	MC2000 Series	MC2100 Series			
Expandable 2-Wide 4-Input AND-OR-INVERT Gate	MC2000 MC2050	MC2100 MC2150	9 5	11 6	7.0	27	4-66
Quad 2-Input NAND Gate	MC2001 MC2051	MC2101 MC2151	9 5	11 6	6.0	88	4-68
4-Wide 3-2-2-3 Input Expander for AND-OR-INVERT Gates	MC2002 MC2052	MC2102 MC2152	9 5	11 6	—	28	4-87
Dual 4-Input NAND Gate	MC2003 MC2053	MC2103 MC2153	9 5	11 6	6.0	44	4-64
Expandable 4-Wide 2-2-2-3 Input AND-OR-INVERT Gate	MC2004 MC2054	MC2104 MC2154	9 5	11 6	7.0	36	4-70
Single 8-Input NAND Gate	MC2005 MC2055	MC2105 MC2155	9 5	11 6	8.0	22	4-62
Dual 4-Input Expander for AND-OR-INVERT Gates	MC2006 MC2056	MC2106 MC2156	9 5	11 6	—	14	4-85
Triple 3-Input NAND Gate	MC2007 MC2057	MC2107 MC2157	9 5	11 6	6.0	66	4-72
AND J-K Flip-Flop	MC2009 MC2059	MC2109 MC2159	9 5	11 6	f = 30 MHz	40	4-76
OR J-K Flip-Flop	MC2010 MC2060	MC2110 MC2160	9 5	11 6	f = 30 MHz	50	4-81
Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate	MC2013 MC2063	MC2113 MC2163	9 5	11 6	8.0	58	4-74

GATES

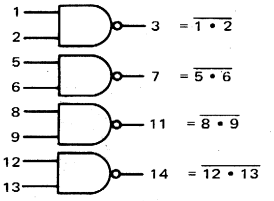
MC2000/MC2050
MC2100/MC2150
Expandable 2-Wide 4-Input AND-OR-INVERT Gate



$12 = \overline{(14 \cdot 1 \cdot 2 \cdot 3) + (5 \cdot 6 \cdot 7 \cdot 8) + \ldots}$

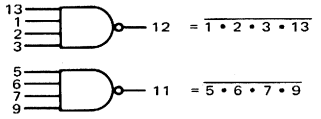
t_{pd} = 7.0 ns typ
P_D = 27 mW typ/Pkg

MC2001/MC2051
MC2101/MC2151
Quad 2-Input NAND Gate



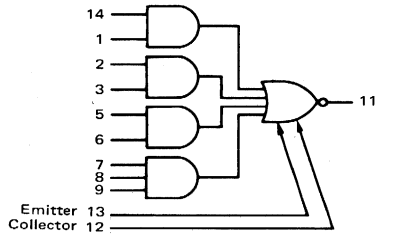
t_{pd} = 6.0 ns typ
P_D = 88 mW typ/Pkg

MC2003/MC2053
MC2103/MC2153
Dual 4-Input NAND Gate



t_{pd} = 6.0 ns typ
P_D = 44 mW typ/Pkg

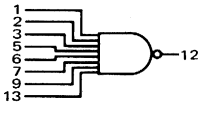
MC2004/MC2054
MC2104/MC2154
Expandable 4-Wide 2-2-2-3 Input AND-OR-INVERT Gate



$11 = \overline{(14 \cdot 1) + (2 \cdot 3) + (5 \cdot 6) + (7 \cdot 8 \cdot 9) + \ldots}$

t_{pd} = 7.0 ns typ
P_D = 36 mW typ/Pkg

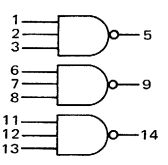
MC2005/MC2055
MC2105/MC2155
Single 8-Input NAND Gate



$12 = \overline{1 \cdot 2 \cdot 3 \cdot 5 \cdot 6 \cdot 7 \cdot 9 \cdot 13}$

t_{pd} = 8.0 ns typ
P_D = 22 mW typ/Pkg

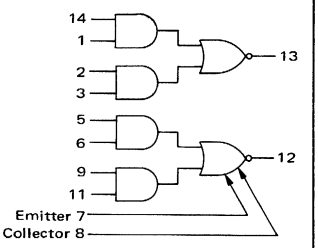
MC2007/MC2057
MC2107/MC2157
Triple 3-Input NAND Gate



$5 = \overline{1 \cdot 2 \cdot 3}$

t_{pd} = 6.0 ns typ
P_D = 66 mW typ/Pkg

MC2013/MC2063
MC2113/MC2163
Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate



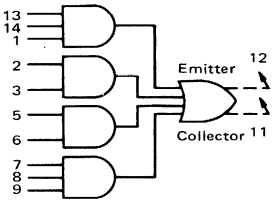
$13 = \overline{(1 \cdot 14) + (2 \cdot 3)}$
$12 = \overline{(5 \cdot 6) + (9 \cdot 11) + \ldots}$

t_{pd} = 8.0 ns typ P_D = 58 mW typ/Pkg

LOGIC DIAGRAMS (continued)

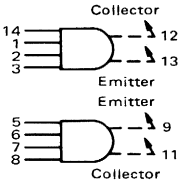
EXPANDERS

MC2002/MC2052
MC2102/MC2152
4-Wide 3-2-2-3 Input Expander For AND-OR-INVERT Gates



P_D = 28 mW typ/Pkg

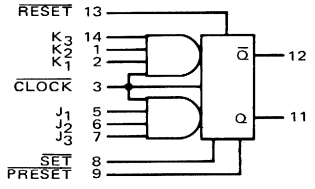
MC2006/MC2056
MC2106/MC2156
Dual 4-Input Expander For AND-OR-INVERT Gates



P_D = 14 mW typ/Pkg

FLIP-FLOPS

MC2009/MC2059
MC2109/MC2159
AND J-K Flip-Flop

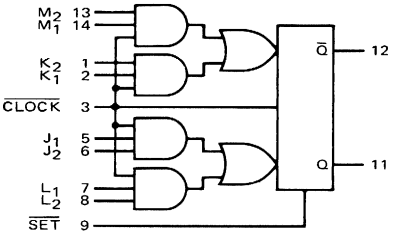


J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Where $J = J_1 \cdot J_2 \cdot J_3$
$K = K_1 \cdot K_2 \cdot K_3$

f = 30 MHz
P_D = 40 mW

MC2010/MC2060
MC2110/MC2160
OR J-K Flip-Flop



J	L	K	M	Q_n	Q_{n+1}
0	0	X	X	0	0
1	X	X	X	0	1
X	1	X	X	0	1
X	X	0	0	1	1
X	X	1	X	1	0
X	X	X	1	1	0

X = Don't Care
Where $J = J_1 \cdot J_2$
$L = L_1 \cdot L_2$
$K = K_1 \cdot K_2$
$M = M_1 \cdot M_2$

f = 30 MHz
P_D = 50 mW

MTTL II

GENERAL INFORMATION SECTION

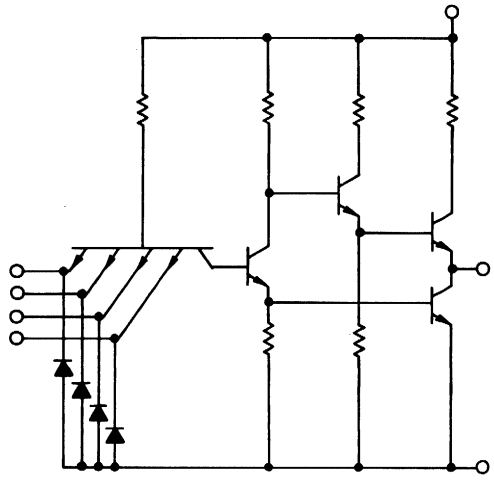
INTRODUCTION

MTTL II transistor-transistor logic is a high-speed, high-noise-immunity family of saturating integrated logic circuits.

The MTTL II family provides a speed extension of the medium-speed MTTL family. The circuits in the MTTL II family are identified by a multiple emitter input transistor and a two-stage active "pull-up" in the upper output network as shown in Figure 1.

The multiple emitter input configuration offers the maximum amount of logic capability in the minimum physical area and provides improved switching characteristics during turnoff. Clamp diodes are provided at each of the inputs to limit undershoot that occurs in typical system applications such as driving long interconnect wiring. The two-stage output configuration provides very low output impedances in each of the two output states. These low impedances result in excellent ac noise immunity and allow high-speed operation while driving large capacitive loads.

FIGURE 1 – TYPICAL MTTL II CIRCUIT



MAXIMUM RATINGS

Rating	Value	Unit
Supply Voltage – Continuous MC2100 Series MC2000 Series	+8.0 +7.0	Vdc
Supply Operating Voltage Range	4.5 to 6.0	Vdc
Input Voltage	+5.5	Vdc
Output Voltage	+5.5	Vdc
Operating Temperature Range MC2100 Series MC2000 Series	-55 to +125 0 to +75	°C
Storage Temperature Range Flat Package Plastic Package	-65 to +200 -55 to +125	°C
Maximum Junction Temperature MC2100 Series MC2000 Series	 +175 +150	°C
Thermal Resistance - Junction To Case (θ_{JC}) Ceramic Flat Package Plastic Dual-In-Line	 0.09 0.15	°C/mW
Thermal Resistance - Junction To Ambient (θ_{JA}) Ceramic Flat Package Plastic Dual-In-Line	 0.26 0.30	°C/mW

TYPICAL CHARACTERISTICS

The following summary presents the typical operating characteristics of the MTTL II family. Unless otherwise indicated, the parameters are defined for V_{CC} = +5.0 volts and T_A = +25°C.

Supply Voltage Operating Range = 4.5 to 6.0 volts

Operating Temperature Range:
MC2100/2150 Series = −55 to +125°C
MC2000/2050 Series = 0 to +75°C

Output Drive Capability
Other Gates (Output Loading Factor):
MC2100 Series = 11 MC2100 or MC2150 Series Gates.
MC2150 Series = 6 MC2100 or MC2150 Series Gates.
MC2000 Series = 9 MC2000 or MC2050 Series Gates.
MC2050 Series = 5 MC2000 or MC2050 Series Gates.

Capacitance = 600 pF

Output Impedance
High State = 10 ohms (unsaturated) nominal
Low State = 10 ohms nominal

Output Voltage Swing = 0.2 to 3.5 volts typical

Input Voltage Limits
+5.5 volts maximum
−0.5 volt minimum

Switching Threshold = 1.5 volts nominal

Input Impedance
High State = 400 k ohms nominal
Low State = 2.5 k ohms nominal

Worst-Case DC Noise Margin
High State — MC2100/2150 series 0.700 volt minimum; MC2000/2050 series 0.600 volt minimum
Low State — MC2100/2150 series 0.650 volt minimum; MC2000/2050 series 0.650 volt minimum

Power Dissipation
22 mW per gate typical
40-50 mW per flip-flop typical

Switching Speeds(1)
Average Propagation Delay = 6.0 ns per gate typical
15 ns per flip-flop typical

Rise Time = 1.0 ns typical
Fall Time = 1.3 ns typical

Flip-Flop Clock Frequency (MC2109/MC2110 Series) = 30 MHz maximum.

BREADBOARDING SUGGESTIONS

When breadboarding with any form of high-speed, high-performance TTL, the designer must continually be aware of the fact that he is working with the fastest form of saturating logic available in the industry today. The switching speeds, especially the frequencies associated with the very fast rise and fall times of the circuits, are in the RF range and good high-frequency layout techniques should be used. The following breadboarding suggestions have been included to help the designer in his initial circuit layout. In many cases the breadboarding suggestions will have to be modified to meet the requirements of the designer's specific application.

Power and Ground Distribution

Special care should be taken to insure adequate distribution of power and ground systems. The typical rate of change of currents and voltages for a single MTTL II gate is in the range of 10^7 A/s and 10^8 V/s respectively. These figures reflect the necessity for a low-impedance power supply and ground distribution system, if transients are to be minimized and noise margins maintained. The use of AWG No. 20 wire or larger is often required. For printed circuitry, line widths of 100 mils or more are often necessary. A ground plane is desirable when using a large number of units.

Bypassing

To reduce supply transients, the breadboard should be bypassed at the point where power is supplied to the board and at intervals throughout the board. The use of a single bypass capacitor at the output terminal of the power supply is not adequate in a breadboard utilizing the fast rise and fall time MTTL II circuits. A comparatively large, low-inductance type capacitor (in the 1.0 μF range) is suggested at the point where power and ground enter the board. In many cases it has been found that distributing 0.01 μF capacitors for every five packages throughout a breadboard is adequate to supress normal switching transients. It is also suggested that a bypass capacitor be placed in close proximity to any circuit driving a large capacitive load.

Power Dissipation

The standard supply voltage of the MTTL II logic circuits is +5.0 Vdc.The typical average dc power dissipation is given for each MTTL II circuit.(2) It should be noted that the totem pole output common to all high level MTTL circuits has an associated ac power dissipation factor. This factor results from the timing overlap of the upper and lower output transistors during the normal switching operation and is typically 0.7 mW/MHz/output for a 15 pF load. This ac power dissipation should be added when calculating the total power requirements of the MTTL II circuits.

Unused Inputs and Unused Gates

The unused inputs of any MTTL II logic circuit should not be left open, and can either be tied to the used inputs or returned to the supply voltage. This will reduce any potential problems resulting from external noise. If the inputs are returned to the supply voltage, care should be taken to insure that the supply voltage does not exceed the maximum rated input voltage of 5.5 volts. If the supply can exceed 5.5 volts, the unused inputs must be returned to a lower voltage. The total number of inputs that can be tied to the output of any driving gate is 50. (This is defined as high state output loading factor.) It should be noted that the low state output loading rules must still be maintained. The minimum logical "1" level for the high state output loading is summarized for V_{CC} = 5.0 V, V_{IL} = 0.45 V and I_{OH} = −5.0 mA:

MC2100/2150 Series — V_{OH} = 2.7 volts minimum @ −55°C
MC2000/2050 Series — V_{OH} = 2.9 volts minimum @ 0°C

The unused inputs of the various flip-flops may be tied back to their associated outputs. To determine which outputs are related to each set of inputs by internal feedback, refer to the circuit schematics.

The inputs of any unused gate in a package should be grounded. This places the gate in its lowest power condition and will help to eliminate unnecessary power drain.

Expanders and Expander Nodes

The ORing nodes of all the MTTL II AND-OR-INVERT gates are made available for expanding the number of AND gates to 10. Since these are comparatively high-impedance nodes, care should be taken to minimize capacitive loading on the expander terminals if switching speed is to be maintained. When an expander is to be used with an expandable AND-OR-INVERT gate, it should be placed as close as possible to the gate being expanded. The increase in the average propagation delay per AND gate added to an expandable AND-OR-INVERT gate is typically 1.0 ns/AND gate. The increase in average propagation delay as a function of capacitance added to the expander nodes is typically 0.7 ns/pF.

Output OR (AND) Function

Unlike the MDTL family of logic circuits, the outputs of the MTTL II logic circuits cannot be tied together to perform the output OR, or more correctly, the output AND function. If the outputs of the MTTL II family devices are tied together, it would be possible for the lower output transistor of one circuit and the upper output transistor of another circuit to be "on" simultaneously. This condition provides a low-impedance path from V_{CC} to ground and the current that flows (approximately I_{SC}) exceeds the guaranteed sink current. As a result, the saturated state cannot be maintained and the desired logic function is not satisfied.

Operating Characteristics of Flip-Flops

The general operating characteristics and restrictions for the MC2109/MC2110 series J-K flip-flops are as follows:

The clocked inputs are inhibited when the clock is in the low state, and data should be applied and allowed to settle. The clocked inputs are enabled when the clock goes high and data enters the flip-flop. The data is temporarily stored in the charge-storage section (temporary memory) while the clock is in the high state. This data is transferred to the bistable section on the negative clock transition.

The data on the clocked inputs should not be changed while the clock is in the high state. Data changes during this clock condition require 300 ns settling time.

The direct $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ inputs do not directly affect the charge-storage section and therefore should not be used while the clock is high. On the negative transition of the clock, previously stored data may override the asynchronous set output state. Further, the direct $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ inputs do not override the clock and will not control the state of the flip-flop until 100 ns after the negative transition of the clock. The clock signal must conform to the following boundary conditions at +125°C.

Maximum guaranteed clock frequency	= 30 MHz
Maximum clock fall time	= 100 ns
Minimum clock pulse width	= 15 ns
Minimum clock pulse amplitude	= 1.8 V
Maximum negative clock voltage	= −0.5 V

Note: These boundary conditions for operation are not defined as occuring simultaneously.

The transfer of data from the charge storage section to the bistable section is essentially an ac operation and thus results in the restriction of the clock fall time. If the clock fall time is greater than 100 ns, the information retained in the charge-storage section may not be transferred to the bistable section. The flip-flop will operate from very low frequencies to 30 MHz as long as the clock fall time is less than or equal to 100 ns.

Large negative clock excursions may cause incorrect data transfers to the bistable section during the transfer cycles. Therefore, the most negative clock signal should be limited to −0.5 volt.

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(1) The switching characteristics of the MTTL II family are defined with respect to the associated transitions of the voltage waveforms. The average propagation delay is defined as the average of the turn-on delay and the turn-off delay measured from the 1.5 V point of the input to the 1.5 V point of the associated output transition or:

$$t_{pd} = \frac{t_{on} + t_{off}}{2} \text{ ns.}$$

Rise time is defined as the positive going transition of the output from the 1.0 V to the 2.0 V level. Fall time is defined as the negative transition of the output from the 2.0 V to the 1.0 V level.

(2)
$$P_D = \frac{I_{PDL} + I_{PDH}}{2} (V_{CC})$$

where I_{PDL} and I_{PDH} are the typical dc current drains at V_{CC} = +5.0 V.

MC2000/2050 and 2100/2150 MTTL II* series integrated circuits are electrically interchangeable with SUHL II† series logic circuits as shown in the cross reference below.

SG SF NUMBER	Description	−55 to +125°C		0 to +75°C	
		Fan-Out = 11	Fan-Out = 6	Fan-Out = 9	Fan-Out = 5
SG210-213	Expandable 2-Wide 4-Input AND-OR-INVERT Gate	MC2100	MC2150	MC2000	MC2050
SG220-223	Quad 2-Input NAND Gate	MC2101	MC2151	MC2001	MC2051
SG230-233	4-Wide 3-2-2-3 Input Expander For AND-OR-INVERT Gates	MC2102	MC2152	MC2002	MC2052
SG240-243	Dual 4-Input NAND Gate	MC2103	MC2153	MC2003	MC2053
SG250-253	Expandable 4-Wide 2-2-2-3 Input AND-OR-INVERT Gate	MC2104	MC2154	MC2004	MC2054
SG260-263	Single 8-Input NAND Gate	MC2105	MC2155	MC2005	MC2055
SG270-273	Dual 4-Input Expander For AND-OR-INVERT Gates	MC2106	MC2156	MC2006	MC2056
–	Triple 3-Input NAND Gate	MC2107	MC2157	MC2007	MC2057
SF250-253	AND J-K Flip-Flop	MC2109	MC2159	MC2009	MC2059
SF260-263	OR J-K Flip-Flop	MC2110	MC2160	MC2010	MC2060
SG310-313	Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate	MC2113	MC2163	MC2013	MC2063

*Trademark of Motorola Inc.
†Trademark of Sylvania Electric Products, Inc.

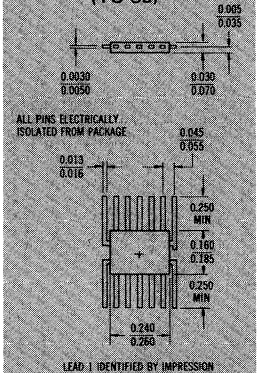
DEFINITIONS

BV_{in} "0"	Input breakdown voltage (ON level)
BV_{in} "1"	Input breakdown voltage (OFF level)
f_{Tog}	Toggle frequency
I_C	Collector current
I_F	Input forward current
I_{FC}	Forward current of clock input
I_{in}	Input current
$2\,I_{in}$	2-times the Input Current
$4\,I_{in}$	4-times the Input Current
I_L	Inverse beta current
I_{LC}	Inverse beta current of the clock input
I_{max}	Maximum rated power supply current with V_{max} applied
I_O	Output breakdown current
I_{OH}	Output high current
I_{OL}	Output low current
I_{OLK}	Output leakage current
I_{PDH}	Power supply drain with inputs high
I_{PDL}	Power supply drain with inputs low
I_R	Input reverse current with V_R applied
I_{RC}	Reverse current of clock input
I_{SC}	Short circuit current obtained from device output when one or more inputs are low
Pr	Prime Fan-Out
PRF	Pulse repetition frequency
PW	Pulse width
Std	Standard fan-out
t_f	Fall time
t_{off}	Turn-off delay time
t_{on}	Turn-on delay time
t_{Post}	The minimal time necessary before the $\overline{SET}$, $\overline{PRESET}$, or $\overline{RESET}$ inputs can control the flip-flop after the negative clock edge
t_r	Rise time
Δt_{pd}	Average increase in propagation delay per AND gate of expander when connected to an AND-OR-INVERT gate.
$\Delta t_{pd}/pF$	Increased propagation delay caused by additional capacitance at expansion points.
TP_{in}	Test point at input of device under test
TP_{out}	Test point at output of device under test
V_{Amp}	Voltage amplitude
V_{CC}	Power supply voltage
V_{CCH}	High power supply voltage
V_{CE}	Collector-emitter voltage
V_{CR}	Collector voltage obtained thru 1.3 k ohm resistor from V_{CC}.
V_{CRH}	Collector voltage obtained thru 1.3 k ohm resistor from V_{CCH}.
V_{E1}, V_{E2}, V_{E3}	Emitter voltage
V_{EN}	Enable voltage level
V_{IH}	Voltage for high input voltage state
V_{IHX}	Reduced supply voltage to hold input above threshold and to prevent noise from entering the device
V_{IL}	Voltage for low input voltage state
V_{INH}	Inhibit voltage level
V_{max}	Maximum rated power supply voltage (V_{CC})
V_{OH}	Output high voltage with I_{OH} flowing out of pin
V_{OL}	Output low voltage with I_{OL} flowing into pin
V_{out} "0"	Output low voltage with V_{th} "1" applied
V_{out} "1"	Output high voltage with V_{th} "0" applied
V_R	Input reverse voltage
V_{th} "0"	Input logic "0" threshold voltage
V_{th} "1"	Input logic "1" threshold voltage

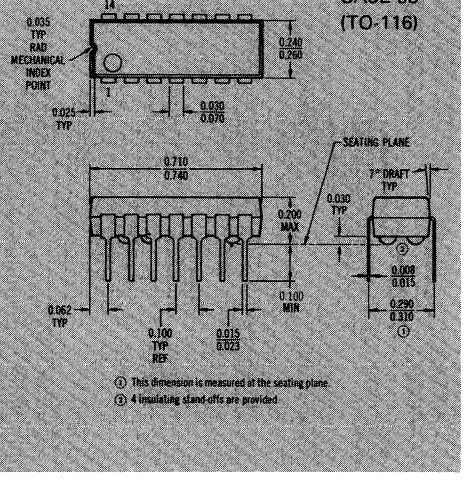
PACKAGING

All MTTL II integrated circuits are available in the TO-85, 14-lead flat package. MC2000 series is also available in the 14-lead dual in-line plastic package. To order the flat package, add suffix "F" to the basic type number; to order plastic package, add suffix "P".

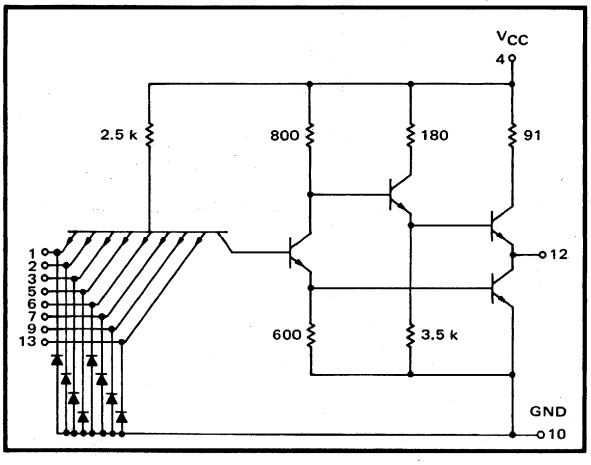
CASE 609
(TO-85)



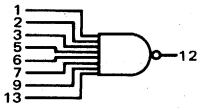
CASE 93
(TO-116)



MC2105 • MC2155
MC2005 • MC2055



This device is an 8-input NAND gate. It is useful when processing a large number of variables, such as in encoders or decoders.



Positive Logic:

$12 = \overline{1 \cdot 2 \cdot 3 \cdot 5 \cdot 6 \cdot 7 \cdot 9 \cdot 13}$

Negative Logic:

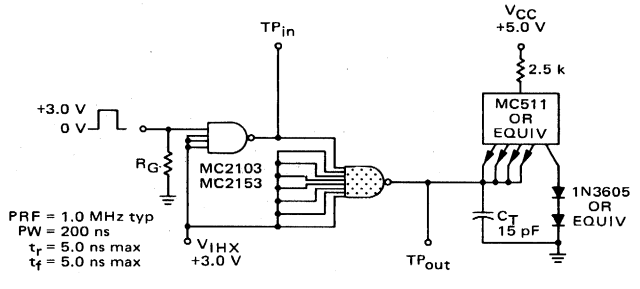
$12 = \overline{1 + 2 + 3 + 5 + 6 + 7 + 9 + 13}$

Total Power Dissipation = 22 mW typ/Pkg

Propagation Delay Time = 8.0 ns typ

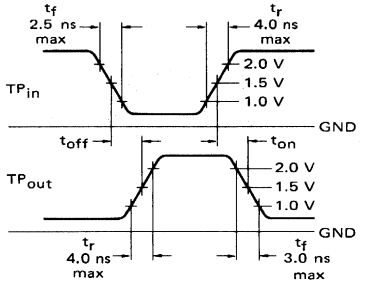
SERIES	INPUT LOADING FACTOR (I_F)		OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC2105 MC2155	1	−2.0 mA	11 6	MC2100 series Gates MC2100 series Gates	22 mA 12 mA	−55°C to +125°C
MC2005 MC2055	1	−2.5 mA	9 5	MC2000 series Gates MC2000 series Gates	22.5 mA 12.5 mA	0°C to +75°C

SWITCHING TIME TEST CIRCUIT



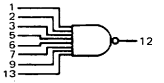
NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input of the device. To complete testing, sequence through remaining inputs in the same manner.

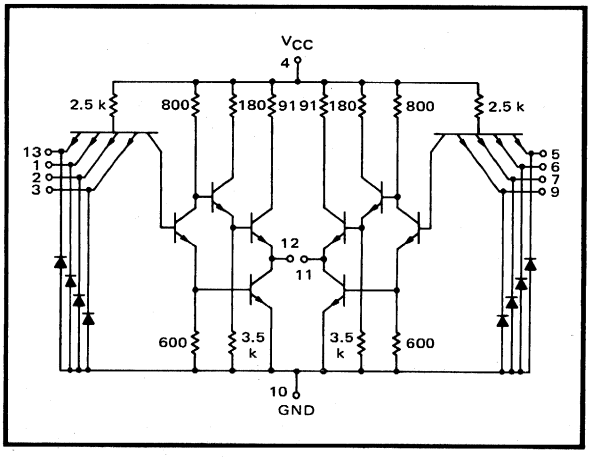


@ Test Temperature		I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	$V_{th\,1}$ Volts	$V_{th\,0}$ Volts	V_{out} Volts	V_{CC} Volts	V_{CCH} Volts	V_{IHX} Volts
MC2105*, MC2155	−55°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	2.0	0.9	5.5	5.0	-	-
	+25°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.7	1.1	5.5	5.0	8.0	3.0
	+125°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.4	0.9	5.5	5.0	-	-
MC2005*, MC2055	0°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.9	1.0	5.5	5.0	-	-
	+25°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.8	1.1	5.5	5.0	7.0	3.0
	+75°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.7	1.0	5.5	5.0	-	-

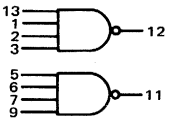
Characteristic	Symbol	Pin Under Test	MC2105, MC2155 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2005, MC2055 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd
Input																												
Forward Current	I_F	1	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	-	-	-	2,3,5,6 7,9,13	-	-	-	4	-	-	1,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,5,6,7, 9,10,13
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,5,6,7, 9,10,13
Output																												
Output Voltage	V_{out} "0"	12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	1	-	-	4	-	-	10
	V_{out} "1"	12	2.5	-	2.4	-	2.5	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	1	-	4	-	-	10
Leakage Current	I_{OLK}	12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	12	4	-	-	1,2,3,5,6,7, 9,10,13
Short-Circuit Current	I_{SC}	12	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6,7, 9,10,12,13
Output Voltage	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	1	-	-	-	-	4	-	-	10
	V_{OH}	12	2.70	-	3.10	-	3.15	-	2.9	-	3.0	-	3.0	-	Vdc	-	12	-	1	-	-	-	-	-	4	-	-	10
Power Requirements (Total Device)																												
Maximum Power Supply Current	I_{max}	4	-	-	-	6.50	-	-	-	-	-	6.75	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,10
Power Supply Drain	I_{PDH}	4	-	7.5	-	7.5	-	7.5	-	10	-	10	-	10	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10
	I_{PDL}	4	-	3.75	-	3.75	-	3.75	-	5.0	-	5.0	-	5.0	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,10
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,12	-	-	-	12	-	-	-	-	-	12	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,9,13	10
Turn-Off Delay	t_{off}	1,12	-	-	-	10	-	-	-	-	-	10	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,9,13	10
Rise Time	t_r	1,12	-	-	-	4.0	-	-	-	-	-	4.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,9,13	10
Fall Time	t_f	1,12	-	-	-	3.0	-	-	-	-	-	3.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,5,6, 7,9,13	10

* Prime Fan-Out.

MC2103 • MC2153
MC2003 • MC2053



This device consists of two 4-input NAND gates. The gates can be cross coupled to form a multiple-input R-S flip-flop or a circuit for eliminating contact bounce.



Positive Logic:
$12 = \overline{1 \cdot 2 \cdot 3 \cdot 13}$

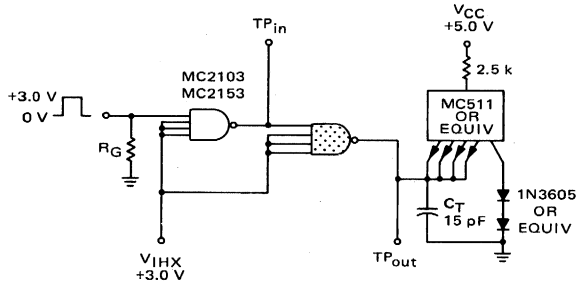
Negative Logic:
$12 = \overline{1 + 2 + 3 + 13}$

Total Power Dissipation = 44 mW typ/Pkg
Propagation Delay Time = 6.0 ns typ

SERIES	INPUT LOADING FACTOR (I_F)		OUTPUT DRIVE (I_{OL})		
MC2103 MC2153	1	−2.0 mA	11 6	MC2100 series Gates MC2100 series Gates	22 mA 12 mA
MC2003 MC2053	1	−2.5 mA	9 5	MC2000 series Gates MC2000 series Gates	22.5 mA 12.5 mA

TEMPERATURE RANGE
−55°C to +125°C
0°C to +75°C

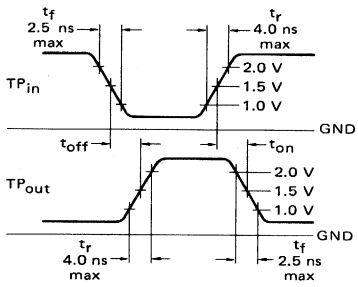
SWITCHING TIME TEST CIRCUIT



PRF = 1.0 MHz typ
PW = 200 ns
t_r = 5.0 ns max
t_f = 5.0 ns max

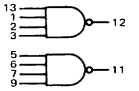
NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Ground inputs to all gates not under test.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gate is tested in a similar manner. Further, test procedures are shown for only one input of the gate being tested. To complete testing, sequence through remaining inputs.

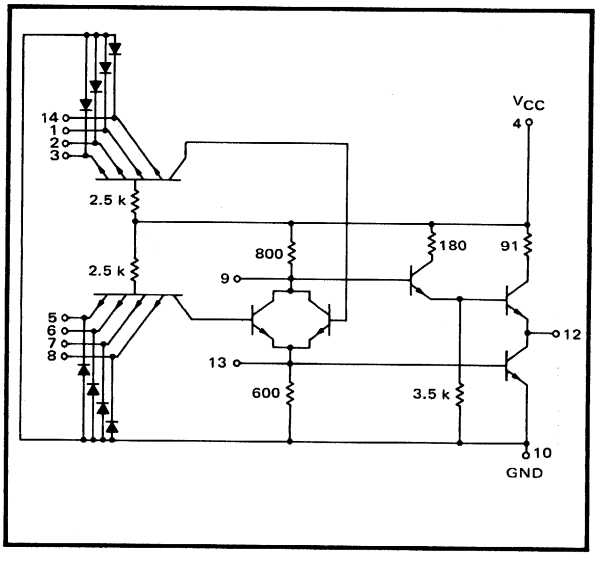


@ Test Temperature		TEST CONDITIONS: mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	Volts V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}
MC2103*, MC2153	−55°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	2.0	0.9	5.5	5.0	-	-
	+25°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.7	1.1	5.5	5.0	8.0	3.0
	+125°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.4	0.9	5.5	5.0	-	-
MC2003*, MC2053	0°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.9	1.0	5.5	5.0	-	-
	+25°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.8	1.1	5.5	5.0	7.0	3.0
	+75°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.7	1.0	5.5	5.0	-	-

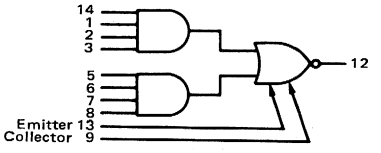
Characteristic	Symbol	Pin Under Test	MC2103, MC2153 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2003, MC2053 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd†
Input																												
Forward Current	I_F	1	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	-	-	-	2, 3, 13	-	-	-	4	-	-	1, 10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2, 3, 10, 13
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2, 3, 10, 13
Output																												
Output Voltage	V_{out} "0"	12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	1	-	-	4	-	-	10
	V_{out} "1"	12	2.5	-	2.4	-	2.5	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	1	-	4	-	-	10
Leakage Current	I_{OLK}	12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	12	4	-	-	1, 2, 3, 10, 13
Short-Circuit Current	I_{SC}	12	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1, 2, 3, 10, 12, 13
Output Voltage	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	1	-	-	-	-	4	-	-	10
	V_{OH}	12	2.70	-	3.10	-	3.15	-	2.9	-	3.0	-	3.0	-	Vdc	-	12	-	1	-	-	-	-	-	4	-	-	10
Power Requirements (Total Device)																												
Maximum Power Supply Current	I_{max}	4	-	-	-	13	-	-	-	-	-	13.5	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1, 5, 10
Power Supply Drain	I_{PDH}	4	-	15	-	15	-	15	-	20	-	20	-	20	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10‡
	I_{PDL}	4	-	7.5	-	7.5	-	7.5	-	10	-	10	-	10	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1, 5, 10
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1, 12	-	-	-	10	-	-	-	-	-	10	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2, 3, 13	10
Turn-Off Delay	t_{off}	1, 12	-	-	-	10	-	-	-	-	-	10	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2, 3, 13	10
Rise Time	t_r	1, 12	-	-	-	4.0	-	-	-	-	-	4.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2, 3, 13	10
Fall Time	t_f	1, 12	-	-	-	2.5	-	-	-	-	-	2.5	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2, 3, 13	10

* Prime Fan-Out.
† Ground inputs to gate not under test during ALL tests unless otherwise noted.
‡ The inputs of both gates must be ungrounded.

MC2100 • MC2150
MC2000 • MC2050



This device consists of two 4-input AND gates ORed together and driving an output inverter. The ORing nodes are available for expansion, and up to 10 AND gates can be ORed together using the MC2102 or the MC2106 series expanders. Since switching speed is affected by the amount of capacitance on the expander nodes, care should be taken to minimize this capacitance to maintain switching speeds. This gate is usable for construction of half adders and other applications where the exclusive OR function is required.



Positive Logic:

$12 = \overline{(1 \cdot 2 \cdot 3 \cdot 14) + (5 \cdot 6 \cdot 7 \cdot 8) + (\text{Expanders})}$

Negative Logic:

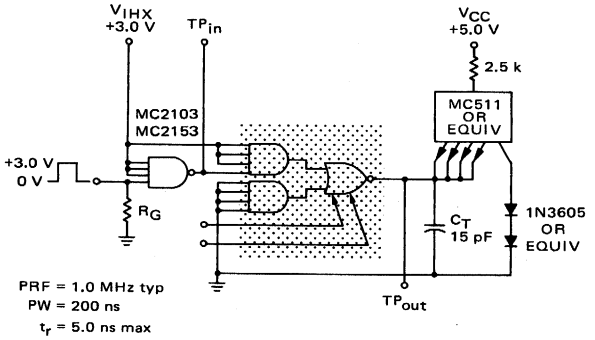
$12 = \overline{(1 + 2 + 3 + 14) \cdot (5 + 6 + 7 + 8) \cdot (\text{Expanders})}$

Total Power Dissipation = 27 mW typ/Pkg

Propagation Delay Time = 7.0 ns typ

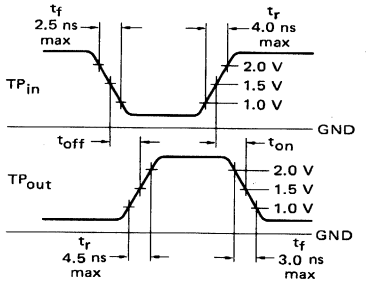
SERIES	INPUT LOADING FACTOR (I_F)		OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC2100 MC2150	1	−2.0 mA	11 6	MC2100 series Gates MC2100 series Gates	22 mA 12 mA	−55°C to +125°C
MC2000 MC2050	1	−2.5 mA	9 5	MC2000 series Gates MC2000 series Gates	22.5 mA 12.5 mA	0°C to +75°C

SWITCHING TIME TEST CIRCUIT



PRF = 1.0 MHz typ
PW = 200 ns
t_r = 5.0 ns max
t_f = 5.0 ns max

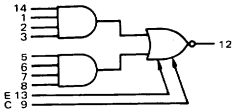
VOLTAGE WAVEFORMS AND DEFINITIONS



NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Expander pins should be left open when measuring switching times.

ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input of the device. To complete testing, sequence through remaining inputs in the same manner.

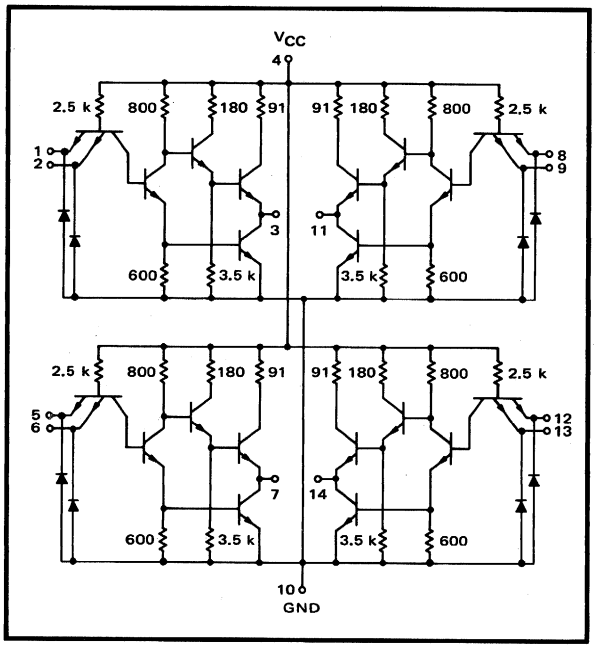


@ Test Temperature		I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	$V_{th\,1}$ Volts	$V_{th\,0}$ Volts	V_{out} Volts	V_{CC} Volts	V_{CCH} Volts	V_{IHX} Volts
MC2100*, MC2150	−55°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	2.0	0.9	5.5	5.0	-	-
	+25°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.7	1.1	5.5	5.0	8.0	3.0
	+125°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.4	0.9	5.5	5.0	-	-
MC2000*, MC2050	0°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.9	1.0	5.5	5.0	-	-
	+25°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.8	1.1	5.5	5.0	7.0	3.0
	+75°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.7	1.0	5.5	5.0	-	-

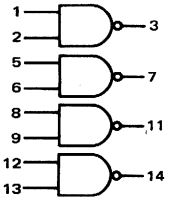
Characteristic	Symbol	Pin Under Test	MC2100, MC2150 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2000, MC2050 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd
Input																												
Forward Current	I_F	1	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	-	-	-	2,3,14	-	-	-	4	-	-	1,5,6,7,8,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,5,6,7,8,10,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	5,6,7,8,10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	5,6,7,8,10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,5,6,7,8,10,14,
Output																												
Output Voltage	V_{out} "0"	12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	1	-	-	4	-	-	5,6,7,8,10
	V_{out} "1"	12	2.5	-	2.4	-	2.5	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	1	-	4	-	-	5,6,7,8,10
Leakage Current	I_{OLK}	12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	12	4	-	-	1,2,3,5,6,7,8,10,14
Short-Circuit Current	I_{SC}	12	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6,7,8,10,12,14
Output Voltage	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	1	-	-	-	-	4	-	-	5,6,7,8,10
	V_{OH}	12	2.70	-	3.10	-	3.15	-	2.9	-	3.0	-	3.0	-	Vdc	-	12	-	1	-	-	-	-	-	4	-	-	5,6,7,8,10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	10	-	-	-	-	-	11	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3,5,6,7,8,10,14
Power Supply Drain	I_{PDH}	4	-	9.0	-	9.0	-	9.0	-	12	-	12	-	12	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10
	I_{PDL}	4	-	6.0	-	6.0	-	6.0	-	7.5	-	7.5	-	7.5	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6,7,8,10,14
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,12	-	-	-	11	-	-	-	-	-	11	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,14	5,6,7,8,10
Turn-Off Delay	t_{off}	1,12	-	-	-	11	-	-	-	-	-	11	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,14	5,6,7,8,10
Rise Time	t_r	1,12	-	-	-	4.5	-	-	-	-	-	4.5	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,14	5,6,7,8,10
Fall Time	t_f	1,12	-	-	-	3.0	-	-	-	-	-	3.0	-	-	ns	1	12	-	-	-	-	-	-	-	4	-	2,3,14	5,6,7,8,10

*Prime Fan-Out.

MC2101 • MC2151
MC2001 • MC2051



This device consists of four 2-input NAND gates. The four gates in a single package represent increased functional flexibility. For example, a dual set-reset flip-flop may be obtained if each pair of gates is externally cross-coupled.



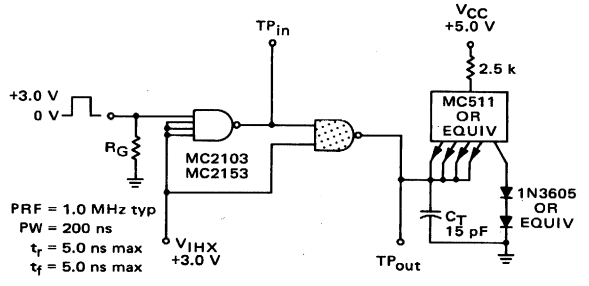
Positive Logic:
$3 = \overline{1 \cdot 2}$

Negative Logic:
$3 = \overline{1 + 2}$

Total Power Dissipation = 88 mW typ/Pkg
Propagation Delay Time = 6.0 ns typ

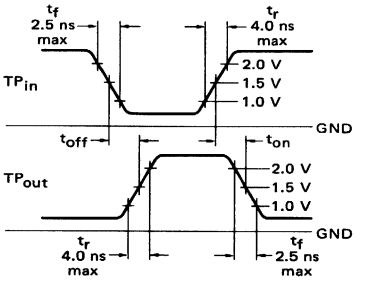
SERIES	INPUT LOADING FACTOR (I_F)		OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC2101 MC2151	1	−2.0 mA	11 6	MC2100 series Gates MC2100 series Gates	22 mA 12 mA	−55°C to +125°C
MC2001 MC2051	1	−2.5 mA	9 5	MC2000 series Gates MC2000 series Gates	22.5 mA 12.5 mA	0°C to +75°C

SWITCHING TIME TEST CIRCUIT



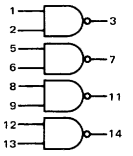
NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Ground inputs to all gates not under test.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gates are tested in a similar manner. Further, test procedures are shown for only one input of the gate being tested. The other input is tested in the same manner.

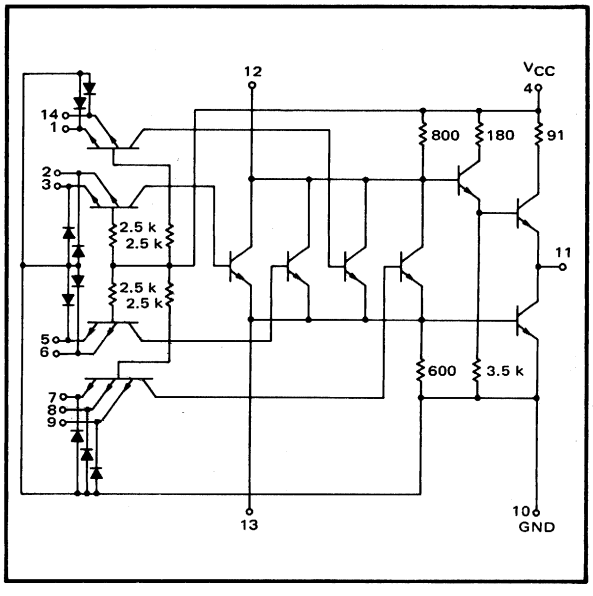


@ Test Temperature		TEST CONDITIONS mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	Volts V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}
MC2101*, MC2151	−55°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	2.0	0.9	5.5	5.0	-	-
	+25°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.7	1.1	5.5	5.0	8.0	3.0
	+125°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.4	0.9	5.5	5.0	-	-
MC2001*, MC2051	0°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.9	1.0	5.5	5.0	-	-
	+25°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.8	1.1	5.5	5.0	7.0	3.0
	+75°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.7	1.0	5.5	5.0	-	-

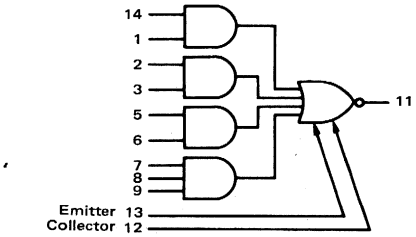
Characteristic	Symbol	Pin Under Test	MC2101, MC2151 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2001, MC2051 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd†
Input																												
Forward Current	I_F	1	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	-	-	-	2	-	-	-	4	-	-	1, 10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2, 10
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2, 10
Output																												
Output Voltage	V_{out} "0"	3	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	3	-	-	-	-	-	1	-	-	4	-	-	10
	V_{out} "1"	3	2.5	-	2.4	-	2.5	-	2.5	-	2.4	-	2.5	-	Vdc	-	3	-	-	-	-	-	1	-	4	-	-	10
Leakage Current	I_{OLK}	3	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	3	4	-	-	1, 2, 10
Short-Circuit Current	I_{SC}	3	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1, 2, 3, 10
Output Voltage	V_{OL}	3	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	3	-	-	-	1	-	-	-	-	4	-	-	10
	V_{OH}	3	2.70	-	3.10	-	3.15	-	2.9	-	3.0	-	3.0	-	Vdc	-	3	-	1	-	-	-	-	-	4	-	-	10
Power Requirements (Total Device)																												
Maximum Power Supply Current	I_{max}	4	-	-	-	26	-	-	-	-	-	27	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1, 5, 8, 10, 12
Power Supply Drain	I_{PDH}	4	-	30	-	30	-	30	-	40	-	40	-	40	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10‡
	I_{PDL}	4	-	15	-	15	-	15	-	20	-	20	-	20	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1, 5, 8, 10, 12
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1, 3	-	-	-	10	-	-	-	-	-	10	-	-	ns	1	3	-	-	-	-	-	-	-	4	-	2	10
Turn-Off Delay	t_{off}	1, 3	-	-	-	10	-	-	-	-	-	10	-	-	ns	1	3	-	-	-	-	-	-	-	4	-	2	10
Rise Time	t_r	1, 3	-	-	-	4.0	-	-	-	-	-	4.0	-	-	ns	1	3	-	-	-	-	-	-	-	4	-	2	10
Fall Time	t_f	1, 3	-	-	-	2.5	-	-	-	-	-	2.5	-	-	ns	1	3	-	-	-	-	-	-	-	4	-	2	10

*Prime Fan-Out
†Ground inputs to gates not under test during ALL tests unless otherwise noted.
‡The inputs of all gates must be ungrounded.

MC2104 • MC2154
MC2004 • MC2054



This device consists of three 2-input and one 3-input AND gates ORed together and driving an output inverter. The ORing nodes are made available for expansion, and up to 10 AND gates can be ORed together using the MC2102 or the MC2106 series expanders. Since switching speed is affected by the amount of capacitance on the expander nodes, care should be taken to minimize this capacitance to maintain switching speeds.



Positive Logic:

$$11 = \overline{(14 \cdot 1) + (2 \cdot 3) + (5 \cdot 6) + (7 \cdot 8 \cdot 9) + (\text{Expanders})}$$

Negative Logic:

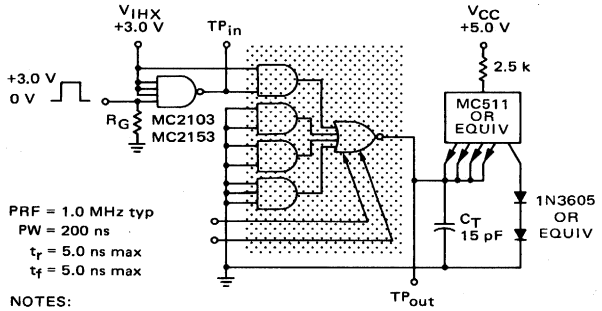
$$11 = \overline{(14 + 1) \cdot (2 + 3) \cdot (5 + 6) \cdot (7 + 8 + 9) \cdot (\text{Expanders})}$$

Total Power Dissipation = 36 mW typ/Pkg

Propagation Delay Time = 7.0 ns typ

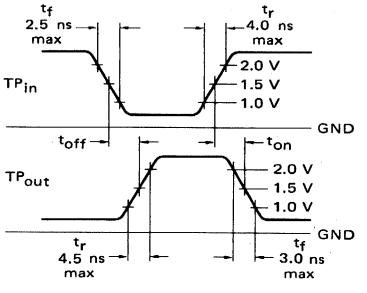
SERIES	INPUT LOADING FACTOR (I_F)		OUTPUT DRIVE (I_{OL})			TEMPERATURE RANGE
MC2104 MC2154	1	−2.0 mA	11 6	MC2100 series Gates MC2100 series Gates	22 mA 12 mA	−55°C to +125°C
MC2004 MC2054	1	−2.5 mA	9 5	MC2000 series Gates MC2000 series Gates	22.5 mA 12.5 mA	0°C to +75°C

SWITCHING TIME TEST CIRCUIT



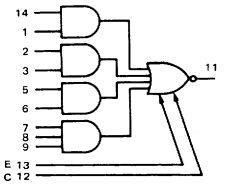
NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Expander pins should be left open when measuring switching times.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input of the device. To complete testing, sequence through remaining inputs in the same manner.

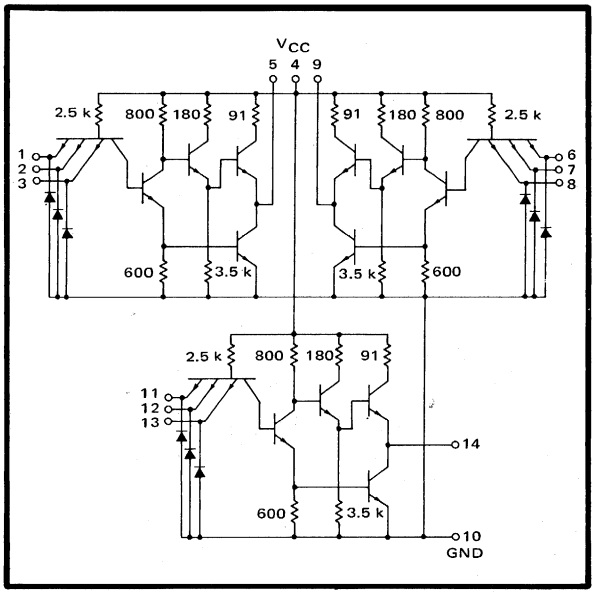


	@ Test Temperature	TEST CONDITIONS mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	Volts V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}
MC2104*, MC2154	−55°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	2.0	0.9	5.5	5.0	-	-
	+25°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.7	1.1	5.5	5.0	8.0	3.0
	+125°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.4	0.9	5.5	5.0	-	-
MC2004*, MC2054	0°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.9	1.0	5.5	5.0	-	-
	+25°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.8	1.1	5.5	5.0	7.0	3.0
	+75°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.7	1.0	5.5	5.0	-	-

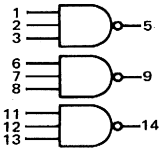
Characteristic	Symbol	Pin Under Test	MC2104, MC2154 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2004, MC2054 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd
Input																												
Forward Current	I_F	1	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	-	-	-	14	-	-	-	4	-	-	1,2,3,5,6,7, 8,9,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,5,6,7,8, 9,10,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,5,6,7, 8,9,10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,5,6,7, 8, 9, 10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,5,6,7, 8, 9, 10, 14
Output																												
Output Voltage	V_{out} "0"	11	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	11	-	-	-	-	-	1	-	-	4	-	-	2,3,5,6,7, 8,9,10
	V_{out} "1"	11	2.5	-	2.4	-	2.5	-	2.5	-	2.4	-	2.5	-	Vdc	-	11	-	-	-	-	-	1	-	4	-	-	2,3,5,6,7, 8, 9, 10
Leakage Current	I_{OLK}	11	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	11	4	-	-	1,2,3,5,6,7, 8,9,10,14
Short-Circuit Current	I_{SC}	11	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6,7, 8,9,10,11, 14
Output Voltage	V_{OL}	11	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	11	-	-	-	1	-	-	-	-	4	-	-	2,3,5,6,7, 8,9,10
	V_{OH}	11	2.70	-	3.10	-	3.15	-	2.9	-	3.0	-	3.0	-	Vdc	-	11	-	1	-	-	-	-	-	4	-	-	2,3,5,6,7, 8,9,10
Power Requirements (Total Device)																												
Maximum Power Supply Current	I_{max}	4	-	-	-	17	-	-	-	-	-	18	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3,5,6,7, 8,9,10,14
Power Supply Drain	I_{PDH}	4	-	12	-	12	-	12	-	16	-	16	-	16	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10
	I_{PDL}	4	-	10	-	10	-	10	-	13	-	13	-	13	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,5,6,7, 8,9,10,14
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,11	-	-	-	12	-	-	-	-	-	12	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	14	2,3,5,6,7, 8,9,10
Turn-Off Delay	t_{off}	1,11	-	-	-	12	-	-	-	-	-	12	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	14	2,3,5,6,7, 8,9,10
Rise Time	t_r	1,11	-	-	-	4.5	-	-	-	-	-	4.5	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	14	2,3,5,6,7, 8,9,10
Fall Time	t_f	1,11	-	-	-	3.0	-	-	-	-	-	3.0	-	-	ns	1	11	-	-	-	-	-	-	-	4	-	14	2,3,5,6,7, 8,9,10

* Prime Fan-Out.

MC2107 • MC2157
MC2007 • MC2057



This device consists of three 3-Input AND gates driving output inverters. These gates can be used to build a pulse shaping network for interfacing with discrete component circuits.

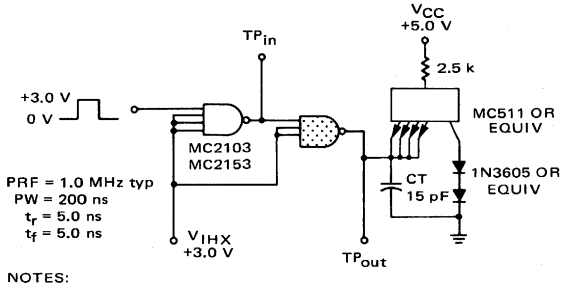


Positive Logic: $5 = \overline{1 \cdot 2 \cdot 3}$
Negative Logic: $5 = \overline{1 + 2 + 3}$

Total Power Dissipation = 66 mW typ/pkg
Propagation Delay Time = 6.0 ns typ

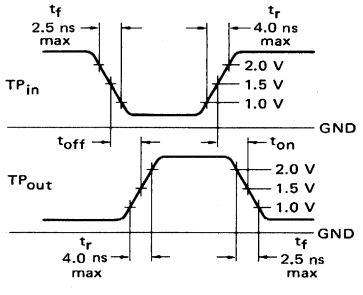
SERIES	INPUT LOADING FACTOR	(I_F)	OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC2107 MC2157	1	(-2.0 mA)	11 6	MC2100 series Gates MC2100 series Gates	(22 mA) (12 mA)	−55°C to +125°C
MC2007 MC2057	1	(-2.5 mA)	9 5	MC2000 series Gates MC2000 series Gates	(22.5 mA) (12.5 mA)	0° to +75°C

SWITCHING TIME TEST CIRCUIT



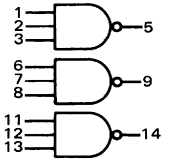
NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
Ground inputs to all gates not under test.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gates are tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.

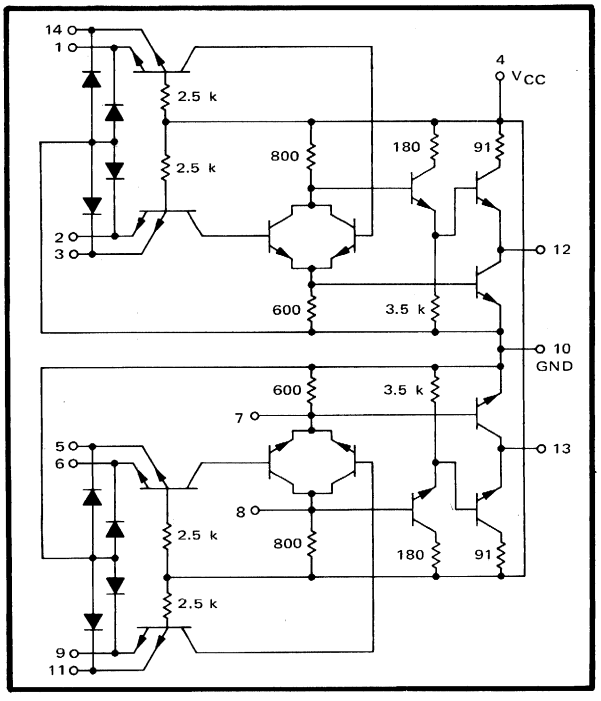


@ Test Temperature		TEST CONDITIONS mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	Volts V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}
MC2107*, MC2157	−55°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	2.0	0.9	5.5	5.0	-	-
	+25°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.7	1.1	5.5	5.0	8.0	3.0
	+125°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.4	0.9	5.5	5.0	-	-
MC2007*, MC2057	0°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.9	1.0	5.5	5.0	-	-
	+25°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.8	1.1	5.5	5.0	7.0	3.0
	+75°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.7	1.0	5.5	5.0	-	-

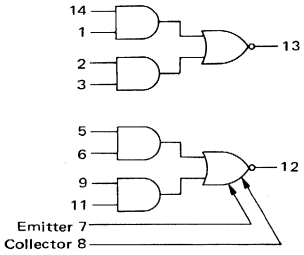
Characteristic	Symbol	Pin Under Test	MC2107, MC2157 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2007, MC2057 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd†
Input																												
Forward Current	I_F	1	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	-	-	-	2,3	-	-	-	4	-	-	1,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,10
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,10
Output																												
Output Voltage	V_{out} "0"	5	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	5	-	-	-	-	-	1	-	-	4	-	-	10
	V_{out} "1"	5	2.5	-	2.4	-	2.5	-	2.5	-	2.4	-	2.5	-	Vdc	-	5	-	-	-	-	-	1	-	4	-	-	10
Leakage Current	I_{OLK}	5	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	5	4	-	-	1,2,3,10
Short-Circuit Current	I_{SC}	5	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3, 5,10
Output Voltage	V_{OL}	5	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	5	-	-	-	1	-	-	-	-	4	-	-	10
	V_{OH}	5	2.7	-	3.1	-	3.15	-	2.9	-	3.0	-	3.0	-	Vdc	-	5	-	1	-	-	-	-	-	4	-	-	10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	19.5	-	-	-	-	-	20.25	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,6,10,11
Power Supply Drain	I_{PDH}	4	-	22.5	-	22.5	-	22.5	-	30	-	30	-	30	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10 ‡
	I_{PDL}	4	-	11.25	-	11.25	-	11.25	-	15	-	15	-	15	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,6,10,11
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,5	-	-	-	10	-	-	-	-	-	10	-	-	ns	1	5	-	-	-	-	-	-	-	4	-	2,3	10
Turn-Off Delay	t_{off}	1,5	-	-	-	10	-	-	-	-	-	10	-	-	ns	1	5	-	-	-	-	-	-	-	4	-	2,3	10
Rise Time	t_r	1,5	-	-	-	4.0	-	-	-	-	-	4.0	-	-	ns	1	5	-	-	-	-	-	-	-	4	-	2,3	10
Fall Time	t_f	1,5	-	-	-	2.5	-	-	-	-	-	2.5	-	-	ns	1	5	-	-	-	-	-	-	-	4	-	2,3	10

* Prime Fan-Out †Ground inputs to gates not under test, during ALL tests unless otherwise noted. ‡ The inputs to all gates must be ungrounded.

MC2113 • MC2163
MC2013 • MC2063



One side of this dual device consists of two 2-input AND gates ORed together and driving an output inverter. The other side consists of two 2-input gates ORed together and driving an output inverter with the ORing nodes made available for expansion. Up to 10 AND gates can be ORed together using the MC2102 or MC2106 expanders series. Care should be taken to minimize the amount of capacitance on the expander terminals in order to maintain switching speeds.



Positive Logic:

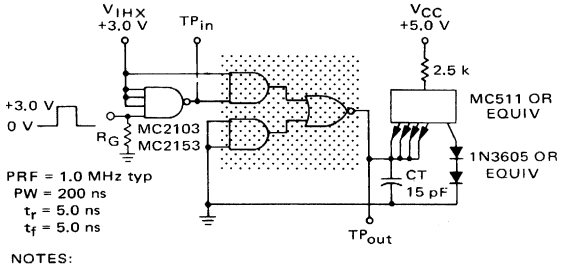
$13 = \overline{(1 \cdot 14) + (2 \cdot 3)}$

$12 = \overline{(5 \cdot 6) + (9 \cdot 11) + (\text{Expander})}$

Total Power Dissipation = 58 mW typ/pkg
Propagation Delay Time = 8.0 ns typ

SERIES	INPUT LOADING FACTOR	(I_F)	OUTPUT DRIVE		(I_{OL})	TEMPERATURE RANGE
MC2113 MC2163	1	(-2.0 mA)	11 6	MC2100 series Gates MC2100 series Gates	(22 mA) (12 mA)	−55°C to +125°C
MC2013 MC2063	1	(-2.5 mA)	9 5	MC2000 series Gates MC2000 series Gates	(22.5 mA) (12.5 mA)	0° to +75°C

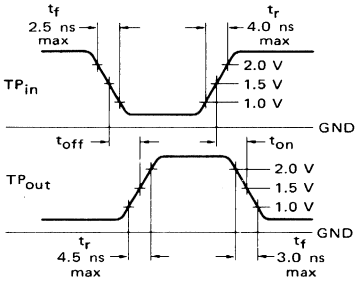
SWITCHING TIME TEST CIRCUIT



PRF = 1.0 MHz typ
PW = 200 ns
t_r = 5.0 ns
t_f = 5.0 ns

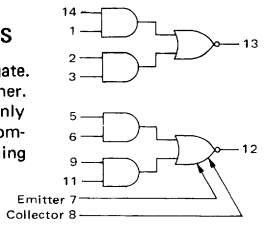
NOTES:
R_G = 50 ohms
C_T = the total parasitic capacitance which includes probe, wiring, and load capacitances.
Scope rise time < 1.0 ns
Probe capacitance < 5.0 pF
When checking expander side, expander pins should be open.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gate is tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.



	@ Test Temperature	TEST CONDITIONS: mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	Volts V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}
MC2113*, MC2163	−55°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	2.0	0.9	5.5	5.0	-	-
	+25°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.7	1.1	5.5	5.0	8.0	3.0
	+125°C	22.0	12.0	-2.2	-1.2	1.0	0.45	2.7	4.5	1.4	0.9	5.5	5.0	-	-
MC2013*, MC2063	0°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.9	1.0	5.5	5.0	-	-
	+25°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.8	1.1	5.5	5.0	7.0	3.0
	+75°C	22.5	12.5	-1.8	-1.0	1.0	0.45	2.9	4.5	1.7	1.0	5.5	5.0	-	-

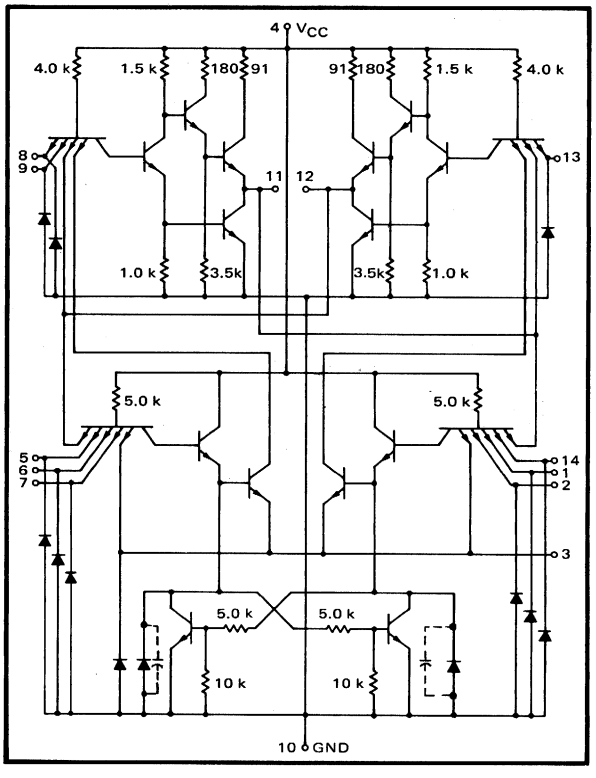
Characteristic	Symbol	Pin Under Test	MC2113, MC2163 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2013, MC2063 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	V_{CCH}	V_{IHX}	Gnd†
Input																												
Forward Current	I_F	1	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	-	-	-	14	-	-	-	4	-	-	1,2,3,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,10,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	1	-	-	-	4	-	-	2,3,10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	4	-	-	2,3,10,14
Output																												
Output Voltage	V_{out} "0"	13	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	13	-	-	-	-	-	1	-	-	4	-	-	2,3,10
	V_{out} "1"	13	2.5	-	2.4	-	2.5	-	2.5	-	2.4	-	2.5	-	Vdc	-	13	-	-	-	-	-	1	-	4	-	-	2,3,10
Leakage Current	I_{OLK}	13	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	-	-	-	13	4	-	-	1,2,3, 10,14
Short-Circuit Current	I_{SC}	13	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	-25	-100	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3,10, 13,14
Output Voltage	V_{OL}	13	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	13	-	-	-	1	-	-	-	-	4	-	-	2,3,10
	V_{OH}	13	2.7	-	3.1	-	3.15	-	2.9	-	3.0	-	3.0	-	Vdc	-	13	-	1	-	-	-	-	-	4	-	-	2,3,10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	20	-	-	-	-	-	22	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3, 10,14
Power Supply Drain	I_{PDH}	4	-	18	-	18	-	18	-	24	-	24	-	24	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	10‡
	I_{PDL}	4	-	12	-	12	-	12	-	15	-	15	-	15	mAdc	-	-	-	-	-	-	-	-	-	4	-	-	1,2,3, 10,14
Switching Parameters																Pulse In	Pulse Out											
Turn-On Delay	t_{on}	1,13	-	-	-	11	-	-	-	-	-	11	-	-	ns	1	13	-	-	-	-	-	-	-	4	-	14	2,3,10
Turn-Off Delay	t_{off}	1,13	-	-	-	11	-	-	-	-	-	11	-	-	ns	1	13	-	-	-	-	-	-	-	4	-	14	2,3,10
Rise Time	t_r	1,13	-	-	-	4.5	-	-	-	-	-	4.5	-	-	ns	1	13	-	-	-	-	-	-	-	4	-	14	2,3,10
Fall Time	t_f	1,13	-	-	-	3.0	-	-	-	-	-	3.0	-	-	ns	1	13	-	-	-	-	-	-	-	4	-	14	2,3,10

* Prime Fan-Out

† Ground inputs to gates not under test during ALL tests unless otherwise noted.

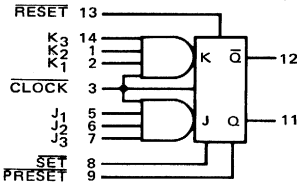
‡ The inputs to all gates must be ungrounded.

MC2109 • MC2159
MC2009 • MC2059

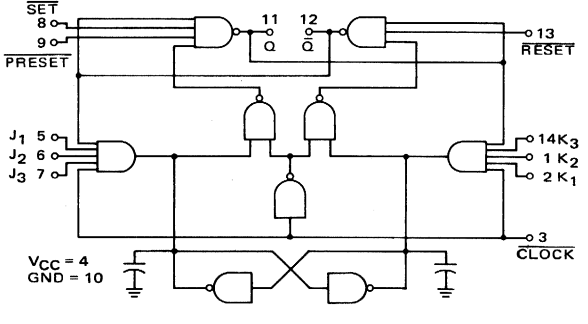


The MC2009, MC2059, MC2109, and MC2159 are clocked flip-flops that trigger on the negative edge and perform the J-K logic junction. Each flip-flop has an AND input gating configuration consisting of three J inputs ANDed together and three K inputs ANDed together. The multiple J and K inputs minimize the requirements for external gates in counters and certain other applications. A direct $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ are also available.

In normal operation, information is changed on the J and K inputs while the clock is in a low state, since the inputs are inhibited in this condition. Information is read into a temporary memory when the clock is in a high state. When the clock returns low, the information is transferred to the bistable section and the Q and $\overline{Q}$ outputs respond accordingly. The information on the J and K inputs should not be changed while the clock is high. Each flip-flop can be set or reset directly by the direct $\overline{SET}$, $\overline{PRESET}$, or $\overline{RESET}$ inputs. Since each flip-flop is a charge-storage device, there is a restriction on the clock fall time that must be observed.



EQUIVALENT CIRCUIT



J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

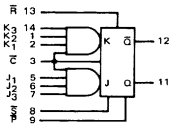
Where $J = J_1 \cdot J_2 \cdot J_3$
$K = K_1 \cdot K_2 \cdot K_3$

Total Power Dissipation = 40 mW typ/Pkg
Switching Times:
t_{on} = 20 ns typ
t_{off} = 13 ns typ

SERIES	INPUT LOADING FACTOR (I_F)				OUTPUT DRIVE (I_{OL})	TEMPERATURE RANGE
	CLOCK	ALL OTHER	CLOCK	ALL OTHER		
MC2109 MC2159	1.00	0.66	(−2.0 mA)	(−1.33 mA)	11 MC2100 series Gates (22.0 mA) 6 MC2100 series Gates (12.0 mA)	−55°C to +125°C
MC2009 MC2059	1.00	0.66	(−2.5 mA)	(−1.66 mA)	9 MC2000 series Gates (22.5 mA) 5 MC2000 series Gates (12.5 mA)	0°C to +75°C

ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one J and K input, plus the $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ inputs. To complete testing, sequence through remaining J and K inputs in the same manner.



@ Test Temperature		I_{OL} mA Pr*	I_{OL} mA Std	I_{OH} mA Pr*	I_{OH} mA Std	I_{in} mA	$2\ I_{in}$ mA	V_{IL} Volts	V_{IH} Volts	V_R Volts	$V_{th\,0}$ Volts	$V_{th\,1}$ Volts	V_{out} Volts	V_{CC} Volts
MC2109*, MC2159	−55°C	22.0	12.0	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	1.0	2.0	5.5	5.0
	+25°C	22.0	12.0	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	1.2	1.7	5.5	5.0
	+125°C	22.0	12.0	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	0.9	1.4	5.5	5.0
MC2009*, MC2059	0°C	22.5	12.5	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.1	1.9	5.5	5.0
	+25°C	22.5	12.5	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.2	1.8	5.5	5.0
	+75°C	22.5	12.5	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.1	1.7	5.5	5.0

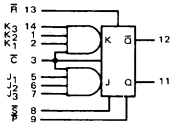
Characteristic	Symbol	Pin Under Test	MC2109, MC2159 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2009, MC2059 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2\ I_{in}$	V_{IL}	V_{IH}	V_R	$V_{th\,0}$	$V_{th\,1}$	V_{out}	V_{CC}	Gnd
Input																											
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	-	2,3,5,6, 7,9,13,14	-	-	-	4	1,8,10
		5	-		-		-		-		-		-			-	-	-	-	-	-	1,2,3,6, 7,8,9,14	-	-	-		5,10,13
		8	-		-		-		-		-		-			-	-	-	-	-	-	1,2,3,5, 6,7,9,14	-	-	-		8,10,13
		9	-		-		-		-		-		-			-	-	-	-	-	-	1,2,3,5, 6,7,8,14	-	-	-		9,10,13
		13	-		-		-		-		-		-			-	-	-	-	-	-	1,2,3,5, 6,7,9,14	-	-	-		8,10,13
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	-	1	-	-	-	4	2,3,5,6,7,10,11,14
		5	-		-		-		-		-		-			-	-	-	-	-	-	5	-	-	-		1,2,3,6,7,10,12,14
		8	-		-		-		-		-		-			-	-	-	-	-	-	8	-	-	-		1,2,3,5,6,7,9,10,12,14
		9	-		-		-		-		-		-			-	-	-	-	-	-	9	-	-	-		1,2,3,5,6,7,8,10,12,14
		13	-		-		-		-		-		-			-	-	-	-	-	-	13	-	-	-		1,2,3,5,6,7,10,11,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	8	-	1	-	-	-	4	10
		5	-		-		-		-		-		-			-	-	-	-	13	-	5	-	-	-		
		8	-		-		-		-		-		-			-	-	-	-		-	8	-	-	-		
		9	-		-		-		-		-		-			-	-	-	-		-	9	-	-	-		
		13	-		-		-		-		-		-			-	-	-	-	8	-	13	-	-	-		
Breakdown Voltage	BV_{in}"0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	8	-	-	-	-	-	4	10
		5		-		-		-		-		-		-		-	-	5	-	13	-	-	-	-	-		
		8		-		-		-		-		-		-		-	-	8	-		-	-	-	-	-		
		9		-		-		-		-		-		-		-	-	9	-		-	-	-	-	-		
		13		-		-		-		-		-		-		-	-	13	-	8	-	-	-	-	-		
	BV_{in}"1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	-	4	2,3,5,6,7,10,11,14
		5		-		-		-		-		-		-		-	-	5	-	-	-	-	-	-	-		1,2,3,6,7,10,12,14
		8		-		-		-		-		-		-		-	-	8	-	-	-	-	-	-	-		1,2,3,5,6,7,9,10,12,14
		9		-		-		-		-		-		-		-	-	9	-	-	-	-	-	-	-		1,2,3,5,6,7,8,10,12,14
		13		-		-		-		-		-		-		-	-	13	-	-	-	-	-	-	-		1,2,3,5,6,7,10,11,14

* Prime Fan-Out.

(continued)

ELECTRICAL CHARACTERISTICS (continued)

Test procedures are shown for only one J and K input, plus the $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ inputs. To complete testing, sequence through remaining J and K inputs in the same manner.



	@ Test Temperature	I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	$2\ I_{in}$	V_{IL}	V_{IH}	V_R	$V_{th\,0}$	$V_{th\,1}$	V_{out}	V_{CC}
		TEST CONDITIONS												
		mA						Volts						
MC2109*, MC2159	−55°C	22.0	12.0	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	1.0	2.0	5.5	5.0
	+25°C	22.0	12.0	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	1.2	1.7	5.5	5.0
	+125°C	22.0	12.0	-1.5	-0.7	1.0	2.0	0.45	2.8	4.5	0.9	1.4	5.5	5.0
MC2009*, MC2059	0°C	22.5	12.5	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.1	1.9	5.5	5.0
	+25°C	22.5	12.5	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.2	1.8	5.5	5.0
	+75°C	22.5	12.5	-1.2	-0.6	1.0	2.0	0.45	3.0	4.5	1.1	1.7	5.5	5.0

Characteristic	Symbol	Pin Under Test	MC2109, MC2159 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2009, MC2059 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2\ I_{in}$	V_{IL}	V_{IH}	V_R	$V_{th\,0}$	$V_{th\,1}$	V_{out}	V_{CC}	Gnd
Clock Input Forward Current	I_F	3	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	-	-	-	-	1,2,5,6, 7,8,9,13,14	-	-	-	4	3,10
Leakage Current	I_R	3	-	150	-	150	-	150	-	150	-	150	-	150	μAdc	-	-	-	-	-	-	3	-	-	-	4	1,2,5,6,7,10,14
Inverse Beta Current	I_L	3	-	200	-	200	-	200	-	200	-	200	-	200	μAdc	-	-	-	-	13	-	3	-	-	-	4	10
		3	-	200	-	200	-	200	-	200	-	200	-	200	μAdc	-	-	-	-	8	-	3	-	-	-	4	10
Breakdown Voltage	BV_{in} "0"	3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	3	13	-	-	-	-	-	4	10
		3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	3	8	-	-	-	-	-	4	10
	BV_{in} "1"	3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	3	-	-	-	-	-	-	4	1,2,5,6,7,10,14
Output Output Voltage	V_{out} "0"	12	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	12	-	-	-	-	-	-	-	13	-	4	3,8,10
		11	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓		11	-	-	-	-	-	-	-	9	-	↓	3,10,13
		11	-		-		-		-		-		-			11	-	-	-	-	-	-	-	8	-		3,10,13
	V_{out} "1"	12	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	12	-	-	-	-	-	13	-	-	4	8,10
		11	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-		-	11	-	-	-	-	-	9	-	-	↓	10,13
		11		-		-		-		-		-		-		-	11	-	-	-	-	-	8	-	-		10,13
Leakage Current	I_{OLK}	12	-	225	-	225	-	225	-	225	-	225	-	225	μAdc	-	-	-	-	-	-	-	-	-	12	4	1,2,3,5,6,7,8,9,10,13,14
		11	-	225	-	225	-	225	-	225	-	225	-	225	μAdc	-	-	-	-	-	-	-	-	-	11	4	1,2,3,5,6,7,8,9,10,13,14
Short-Circuit Current	I_{SC}	12	-	-	-30	-70	-	-	-	-	-30	-70	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	1,2,3,5,6,7,8,9,10,12,13,14
		11	-	-	-30	-70	-	-	-	-	-30	-70	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	4	1,2,3,5,6,7,8,9,10,11,13,14
Output Voltage	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12	-	-	-	-	13	-	-	-	-	4	3,8,10
		11	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓		11	-	-	-	-	9	-	-	-	-	↓	3,10,13
		11	-		-		-		-		-		-			11	-	-	-	-	8	-	-	-	-		3,10,13
	V_{OH}	12	2.80	-	3.20	-	3.35	-	3.00	-	3.10	-	3.15	-	Vdc	-	12	-	-	13	-	-	-	-	-	4	8,10
		11	↓	-		-	↓	-	↓	-	↓	-	↓	-		-	11	-	-	9	-	-	-	-	-	↓	10,13
		11		-		-		-		-		-		-		-	11	-	-	8	-	-	-	-	-		10,13
Power Requirements (Total Device) Power Supply Drain	I_{PD}	4	-	12	-	12	-	12	-	14	-	14	-	14	mAdc	-	-	-	-	-	-	-	-	-	-	4	3,10,13
	I_{PD}	4	-	12	-	12	-	12	-	14	-	14	-	14	mAdc	-	-	-	-	-	-	-	-	-	-	4	3,8,10

* Prime Fan-Out.

OPERATING CHARACTERISTICS

Clock fall time ≤ 100 ns.

Triggers on clock pulse widths ≥ 15 ns.

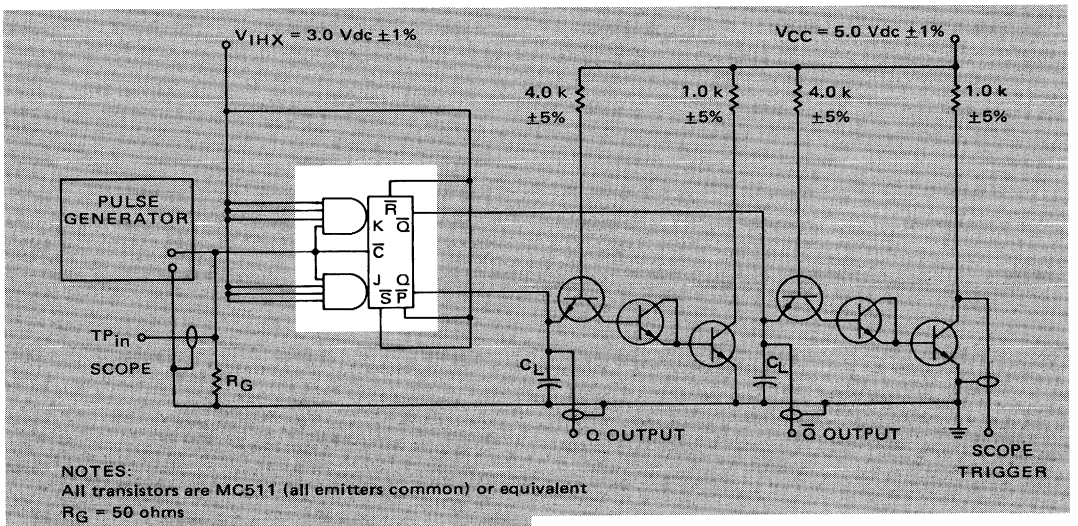
Provides direct $\overline{SET}$, $\overline{PRESET}$, and $\overline{RESET}$ inputs. The application of a "0" state to 8 or 9, sets Q high; "0" state to 13, resets Q low. The clock must be in the low state when these functions are performed.

Data at the J and K inputs must be present before the clock goes to a high state. If the information on the J and K inputs is changed while the clock is in a high state, the flip-flop will require typically 300 ns to recognize a "1" state to "0" state information change on the J and K terminals. The flip-flop will require typically 6.0 ns to recognize a "0" state to "1" state change.

Negative edge triggering – When the clock goes from the high state to the low state, the information in the temporary storage section is transferred and the Q and $\overline{Q}$ outputs will respond accordingly. While the clock is in a low state, the J and K terminals are inhibited.

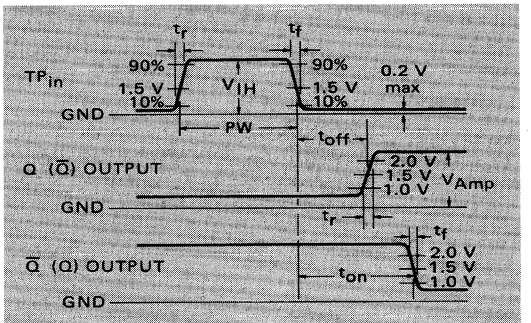
Unused J and K inputs should be tied to the clock or to 2.0 to 5.0 Vdc. $\overline{PRESET}$ and $\overline{SET}$ are tied to $\overline{Q}$; $\overline{RESET}$ is tied to Q.

FIGURE 1 – SWITCHING AND TRIGGER CHARACTERISTICS TEST CIRCUIT



NOTES:
All transistors are MC511 (all emitters common) or equivalent
R_G = 50 ohms
C_L = 15 pF including stray capacitance

VOLTAGE WAVEFORMS AND DEFINITIONS



SWITCHING TIMES

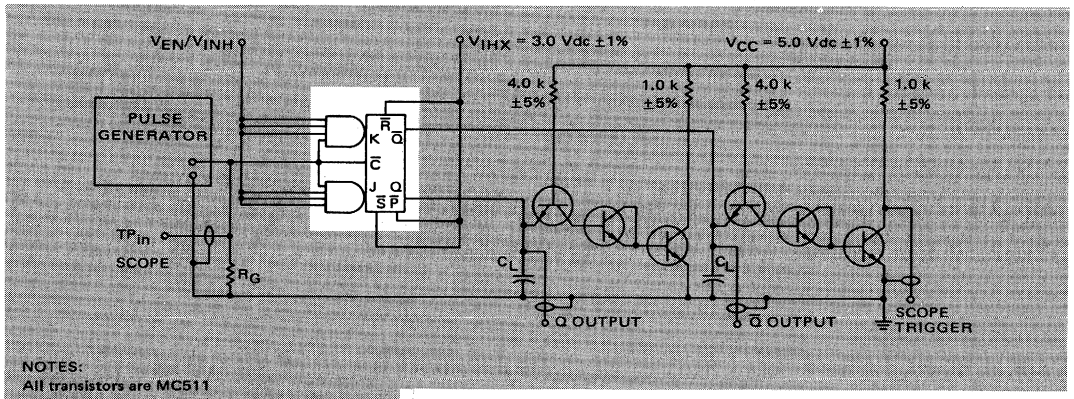
TEST	TEST SYMBOL	INPUT PULSE	MIN	MAX	UNIT
Delay Time Off	t_{off}	V		20	ns
Delay Time On	t_{on}	V		25	ns
Rise Time	t_r	V		6.0	ns
Fall Time	t_f	V		4.0	ns
Amplitude	V_{Amp}	V	3.2		Volt

WORST-CASE TESTS (Device must toggle with each clock pulse)			
TEST	SYMBOL	LIMITS	INPUT CONDITIONS
Toggle Frequency	f_{Tog}	30 MHz max	W
Pulse Width	PW	15 ns min	X
Input High Voltage	V_{IH}	1.8 V min	Y
Fall Time	t_f	100 ns max	Z

INPUT PULSE CONDITIONS

SYMBOL	W	V	X	Y	Z	UNIT
PRF	30	5.0	5.0	5.0	1.0	MHz
PW	15	100	15	100	200	ns
t_r	≤10	≤10	≤10	≤10	≤50	ns
t_f	≤10	≤10	≤10	≤10	100	ns
V_{IH}	3.5	3.5	3.5	1.8	3.5	Volt

FIGURE 2 – J-K TERMINAL CHARACTERISTICS TEST CIRCUIT



NOTES:
All transistors are MC511 (all emitters common) or equivalent
R_G = 50 ohms
C_L = 15 pF including stray capacitance

Enable Mode Test:
The device under test shall toggle when V_{EN} = 1.8 Vdc ±1% is applied.

Inhibit Mode Test:
The device under test shall NOT toggle when V_{INH} = 1.2 Vdc ±1% is applied.

INPUT VOLTAGE WAVEFORMS AND DEFINITIONS

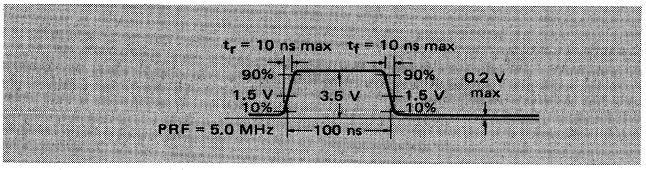
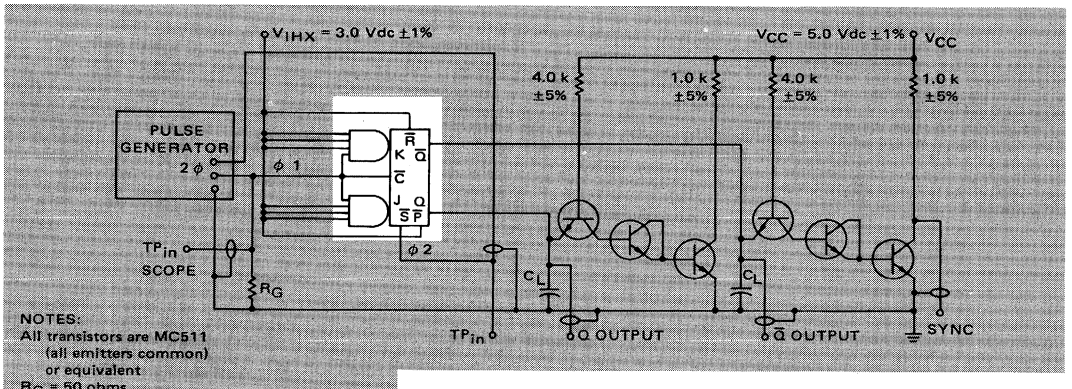


FIGURE 3 – SET-RESET-PRESET TERMINAL CHARACTERISTICS TEST CIRCUIT



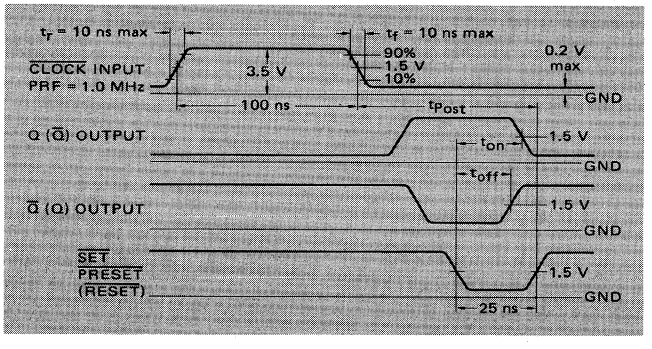
NOTES:
All transistors are MC511 (all emitters common) or equivalent
R_G = 50 ohms
C_L = 15 pF including stray capacitance
t_{Post} = Post Time

TEST PARAMETERS

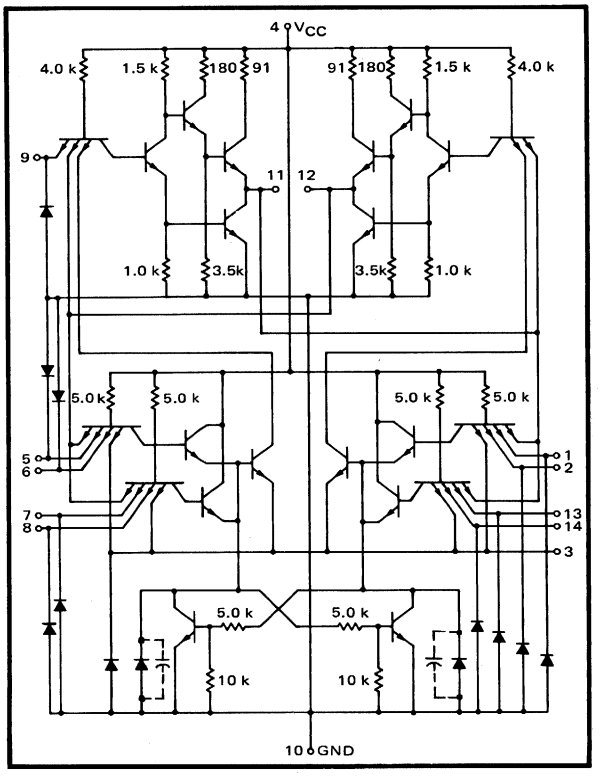
SYMBOL	VALUE	UNIT
t_{Post}	100	ns min
t_{on}	25	ns max
t_{off}	20	ns max

NOTE:
When t_{Post} is 100 ns, SET, PRESET or RESET pulses must actuate the device.
SET, PRESET, and RESET pulse cannot return to the high state before the required post time.
Connections shown for measuring times related to SET terminal only. To measure times at PRESET terminal apply input pulse to Pin 9 in place of Pin 8. To measure times at RESET terminals, apply the input pulse to Pin 13.

VOLTAGE WAVEFORMS AND DEFINITIONS



MC2110 • MC2160
MC2010 • MC2060

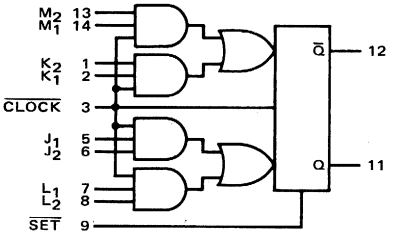


The MC2110, MC2160, MC2010, and MC2060 are clocked flip-flops that trigger on the negative edge and are internally wired to perform the J-K logic function. Each flip-flop has a positive logic AND-OR input gating configuration that consists of two clocked J inputs ANDed together, two clocked K inputs ANDed together, two clocked L inputs ANDed together, and two clocked M inputs ANDed together. The J and the L inputs are ORed together and the K and the M inputs are ORed together. A direct $\overline{SET}$ is also available.

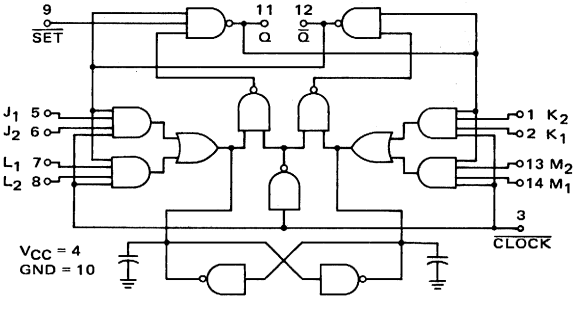
In normal operation, information is changed on the clocked inputs while the clock is in a low state, since the inputs are inhibited in this condition. Information is read into a temporary memory through the AND-OR input gating when the clock is in the high state. When the clock returns low the information in the temporary memory is transferred to the bistable section and the Q and the $\overline{Q}$ outputs respond accordingly. The information on the clocked inputs should not be changed while the clock is high.

Each flip-flop can be set directly by applying a low state to the direct $\overline{SET}$ input. Since each flip-flop is a charge storage device there is a restriction on the clock fall time that must be observed.

The AND-OR input configuration of each flip-flop makes it very useful for shift right/shift left registers and for up/down counters.



EQUIVALENT CIRCUIT



J	L	K	M	Q_n	Q_{n+1}
0	0	X	X	0	0
1	X	X	X	0	1
X	1	X	X	0	1
X	X	0	0	1	1
X	X	1	X	1	0
X	X	X	1	1	0

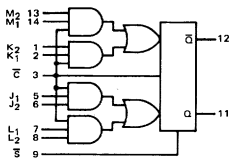
X = Don't Care
Where $J = J_1 \cdot J_2$
$L = L_1 \cdot L_2$
$K = K_1 \cdot K_2$
$M = M_1 \cdot M_2$

Total Power Dissipation = 50 mW typ/Pkg
Switching Times:
t_{on} = 20 ns typ
t_{off} = 13 ns typ

SERIES	INPUT LOADING FACTOR (I_F)				OUTPUT DRIVE (I_{OL})	TEMPERATURE RANGE
	CLOCK	ALL OTHER	CLOCK	ALL OTHER		
MC2110 MC2160	2.00	0.66	(−4.0 mA)	(−1.33 mA)	11 MC2100 series Gates (22.0 mA) 6 MC2100 series Gates (12.0 mA)	−55°C to +125°C
MC2010 MC2060	2.00	0.66	(−5.0 mA)	(−1.66 mA)	9 MC2000 series Gates (22.5 mA) 5 MC2000 series Gates (12.5 mA)	0°C to +75°C

ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one J, one K, and the $\overline{SET}$ input. The remaining J, K, L, M inputs are tested in the same manner.



	@ Test Temperature	TEST CONDITIONS mA I_{OL} Pr*	I_{OL} Std	I_{OH} Pr*	I_{OH} Std	I_{in}	2 I_{in}	4 I_{in}	Volts V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}
MC2110*, MC2160	−55°C	22.0	12.0	-1.5	-0.7	1.0	2.0	4.0	0.45	2.8	4.5	2.0	1.0	5.5	5.0
	+25°C	22.0	12.0	-1.5	-0.7	1.0	2.0	4.0	0.45	2.8	4.5	1.7	1.2	5.5	5.0
	+125°C	22.0	12.0	-1.5	-0.7	1.0	2.0	4.0	0.45	2.8	4.5	1.4	0.9	5.5	5.0
MC2010*, MC2060	0°C	22.5	12.5	-1.2	-0.6	1.0	2.0	4.0	0.45	3.0	4.5	1.9	1.1	5.5	5.0
	+25°C	22.5	12.5	-1.2	-0.6	1.0	2.0	4.0	0.45	3.0	4.5	1.8	1.2	5.5	5.0
	+75°C	22.5	12.5	-1.2	-0.6	1.0	2.0	4.0	0.45	3.0	4.5	1.7	1.1	5.5	5.0

Characteristic	Symbol	Pin Under Test	MC2110, MC2160 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2010, MC2060 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	2 I_{in}	4 I_{in}	V_{IL}	V_{IH}	V_R	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CC}	Gnd
Input																												
Forward Current	I_F	1	-	-1.33	-	-1.33	-	-1.33	-	-1.66	-	-1.66	-	-1.66	mAdc	-	-	-	-	-	-	-	2,3,5,6,7, 8,13,14	-	-	-	4	1,9,10
		5	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	1,2,3,6,7, 8,13,14	-	-	-	↓	5,10,11
		9	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	1,2,5,6,7, 8,13,14	-	-	-	↓	3,9,10,11
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	-	-	1	-	-	-	4	2,3,5,6,7,8,10,11,13,14
		5	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	5	-	-	-	↓	1,2,3,6,7,8,9,10,12,13,14
		9	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	9	-	-	-	↓	1,2,3,5,6,7,8,10,12,13,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	-	-	-	-	-	1	-	-	-	4	9,10
		5	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	5	-	-	-	↓	10,11
		9	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	9	-	-	-	↓	10,11
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	-	-	4	9,10
		5	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	5	-	-	-	-	-	-	-	-	↓	10,11
		9		-		-		-		-		-		-	↓	-	-	9	-	-	-	-	-	-	-	-	↓	10,11
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	1	-	-	-	-	-	-	-	-	4	2,3,5,6,7,8,10,11,13,14
		5	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	↓	-	-	5	-	-	-	-	-	-	-	-	↓	1,2,3,6,7,8,9,10,12,13,14
		9		-		-		-		-		-		-	↓	-	-	9	-	-	-	-	-	-	-	-	↓	1,2,3,5,6,7,8,10,12,13,14
Clock Input Forward Current	I_F	3	-	-4.0	-	-4.0	-	-4.0	-	-5.0	-	-5.0	-	-5.0	mAdc	-	-	-	-	-	-	-	1,2,5,6,7, 8,13,14	-	-	-	4	3,10
Leakage Current	I_R	3	-	300	-	300	-	300	-	300	-	300	-	300	μAdc	-	-	-	-	-	-	-	3	-	-	-	4	1,2,5,6,7,8,10,13,14
Inverse Beta Current	I_L	3	-	400	-	400	-	400	-	400	-	400	-	400	μAdc	-	-	-	-	-	-	-	3	-	-	-	4	9,10
		3	-	400	-	400	-	400	-	400	-	400	-	400	μAdc	-	-	-	-	-	-	-	3	-	-	-	4	10,11
Breakdown Voltage	BV_{in} "0"	3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	-	3	-	-	-	-	-	-	4	10, 11
		3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	-	3	-	-	-	-	-	-	4	10, 12
	BV_{in} "1"	3	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	-	-	3	-	-	-	-	-	-	-	4	1,2,5,6,7,8,10,13,14
Output (For Set Only) Output Voltage	V_{out} "0"	11	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	-	0.45	Vdc	11①	-	-	-	-	-	-	-	9	-	-	4	3, 10
	V_{out} "1"	11	2.5	-	2.4	-	2.7	-	2.5	-	2.4	-	2.5	-	Vdc	-	11	-	-	-	-	-	-	-	9	-	4	3,10
Leakage Current	I_{OLK}	12	-	650	-	650	-	650	-	650	-	650	-	650	μAdc	-	-	-	-	-	-	-	12	-	-	-	4	1,2,3,5,6,7,8,10,11,13,14
		11	-	650	-	650	-	650	-	650	-	650	-	650	μAdc	-	-	-	-	-	-	-	11	-	-	-	4	1,2,3,5,6,7,8,9,10,13,14
Short-Circuit Current	I_{SC}	12	-	-	-30	-70	-	-	-	-	-30	-70	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	1,2,3,5,6,7,8,10,11,12,13,14
		11	-	-	-30	-70	-	-	-	-	-30	-70	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	1,2,3,5,6,7,8,9,10,11,13,14
Output Voltage	V_{OH}	12	2.80	-	3.20	-	3.35	-	3.00	-	3.10	-	3.15	-	Vdc	-	12	-	-	-	-	-	-	-	-	-	4	3,10,11
		11	2.80	-	3.20	-	3.35	-	3.00	-	3.10	-	3.15	-	Vdc	-	11	-	-	-	-	-	-	-	-	-	4	3,10,12
	V_{OL}	12	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	12①	-	-	-	-	-	9	-	-	-	-	4	3,10
		11	-	0.40	-	0.40	-	0.45	-	0.40	-	0.40	-	0.45	Vdc	11①	-	-	-	-	-	9	-	-	-	-	4	3,10
Breakdown Voltage	I_O	12	-	4.25	-	4.25	-	4.25	-	4.25	-	4.25	-	4.25	mAdc	-	-	-	-	-	-	-	-	-	-	12	4	1,2,3,5,6,7,8,10,11,13,14
		11	-	4.25	-	4.25	-	4.25	-	4.25	-	4.25	-	4.25	mAdc	-	-	-	-	-	-	-	-	-	-	11	4	1,2,3,5,6,7,8,9,10,13,14
Power Requirements (Total Device) Power Supply Drain	I_{PD}	4	-	15	-	15	-	15	-	18	-	18	-	18	Vdc	-	-	-	-	-	-	-	-	-	-	-	4	3,10,12
	I_{PD}	4	-	15	-	15	-	15	-	18	-	18	-	18	Vdc	-	-	-	-	-	-	-	-	-	-	-	4	3,10,11

* Prime Fan-Out ① Momentarily ground pin prior to taking measurement at terminal.

OPERATING CHARACTERISTICS

Clock fall time $\leq$ 100 ns.

Triggers on clock pulse widths $\geq$15 ns.

The application of a "0" state to the $\overline{SET}$ will cause Q to go to the "1" state. The clock must be in the low state when this function is performed.

Data at the clocked inputs must be present before the clock goes to a high state. If the information on the clocked inputs is changed while the clock is in a high state, the flip-flop will require typically 300 ns to recognize a "1" state to "0" state change. The flip-flop will also require typically 6.0 ns to recognize a "0" state to "1" state change.

Negative edge triggering – When the clock goes from the high state, the information in the temporary storage section is transferred; and the Q and $\overline{Q}$ outputs will change accordingly. While the clock is in a low state, the J, K, L, and M terminals are inhibited.

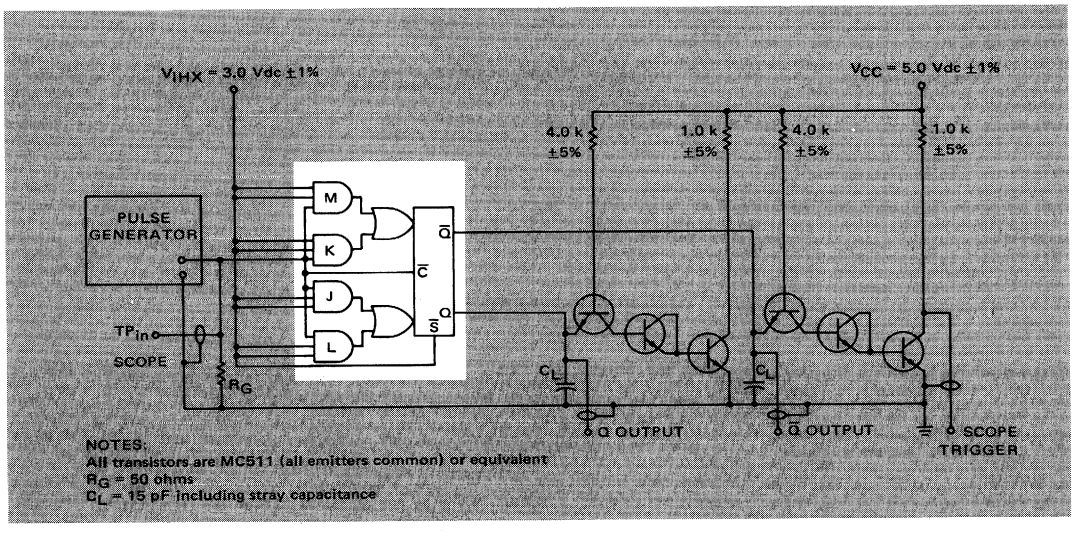
Unused Inputs:

Single unused J, K, L, and M inputs should be tied to the used input, to the clock input, or to 2.0 to 5.0 Vdc.

If both J, K, L, or M inputs are unused, they MUST be tied to ground.

Unused $\overline{SET}$ is tied to $\overline{Q}$.

FIGURE 1 – SWITCHING AND TRIGGER CHARACTERISTICS TEST CIRCUIT



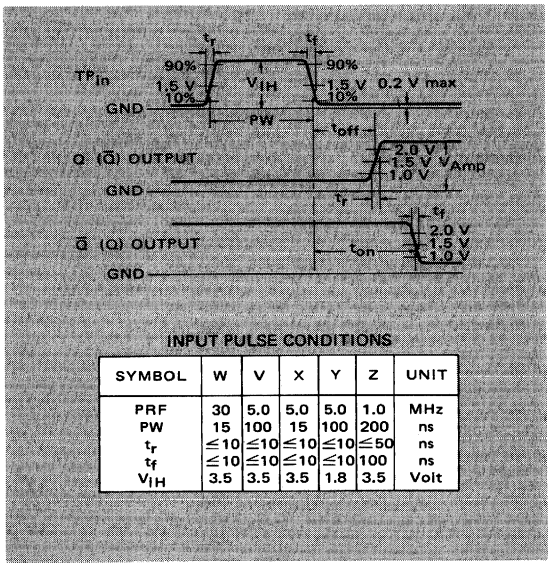
SWITCHING TIMES

TEST	TEST SYMBOL	INPUT PULSE	MIN	MAX	UNIT
Delay Time Off	t_{off}	V		20	ns
Delay Time On	t_{on}	V		25	ns
Rise Time	t_r	V		6.0	ns
Fall Time	t_f	V		4.0	ns
Amplitude	V_{Amp}	V	3.2		Volt

WORST-CASE TESTS
(Device must toggle with each clock pulse)

TEST	SYMBOL	LIMITS	INPUT CONDITIONS
Toggle Frequency	f_{Tog}	30 MHz max	W
Pulse Width	PW	15 ns min	X
Input High Voltage	V_{IH}	1.8 V min	Y
Fall Time	t_f	100 ns max	Z

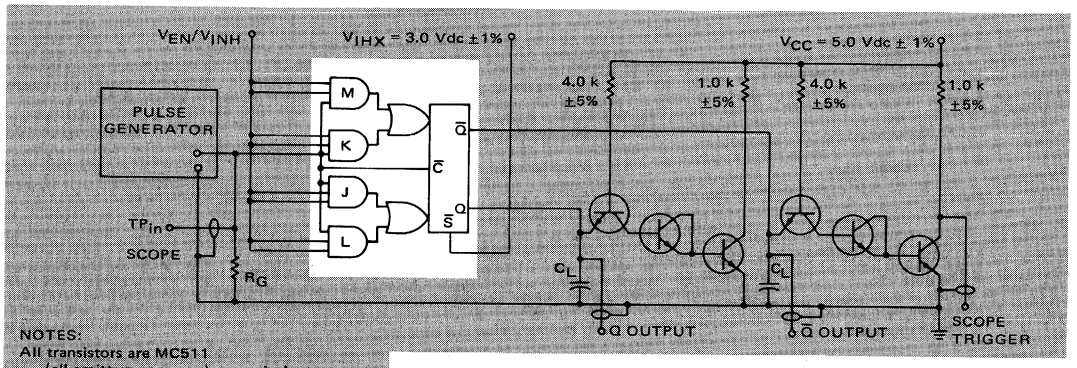
VOLTAGE WAVEFORMS AND DEFINITIONS



INPUT PULSE CONDITIONS

SYMBOL	W	V	X	Y	Z	UNIT
PRF	30	5.0	5.0	5.0	1.0	MHz
PW	15	100	15	100	200	ns
t_r	$\leq$10	$\leq$10	$\leq$10	$\leq$10	$\leq$50	ns
t_f	$\leq$10	$\leq$10	$\leq$10	$\leq$10	100	ns
V_{IH}	3.5	3.5	3.5	1.8	3.5	Volt

FIGURE 2 – J-K-L-M TERMINAL CHARACTERISTICS TEST CIRCUIT



NOTES:
All transistors are MC511 (all emitters common) or equivalent
R_G = 50 ohms
C_L = 15 pF including stray capacitance
Enable Mode Test:
The device under test shall toggle when V_{EN} = 1.8 Vdc ±1% is applied.
Inhibit Mode Test:
The device under test shall NOT toggle when V_{INH} = 1.2 Vdc ±1% is applied.

INPUT VOLTAGE WAVEFORMS AND DEFINITIONS

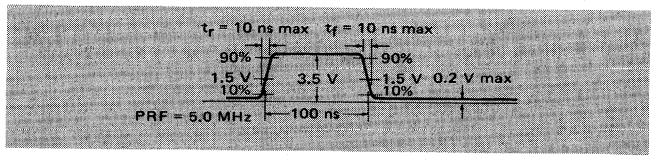
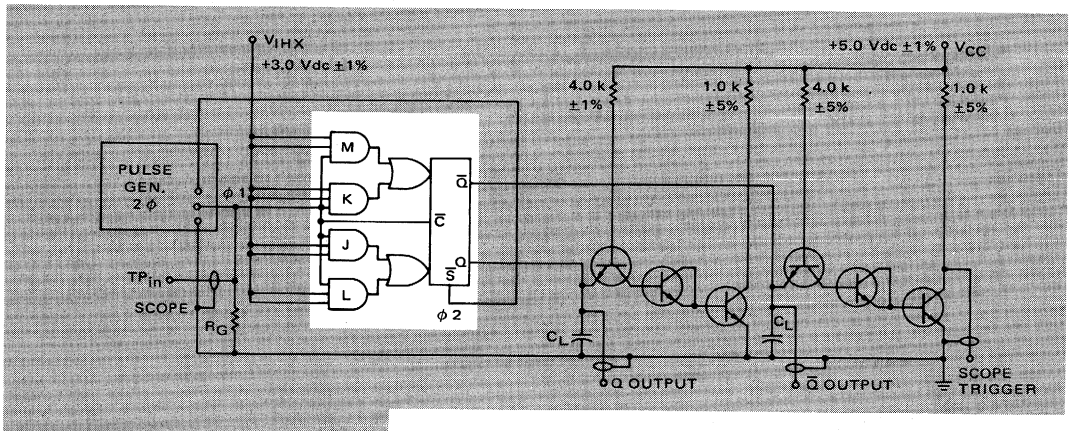


FIGURE 3 – $\overline{SET}$ TERMINAL CHARACTERISTICS TEST CIRCUIT



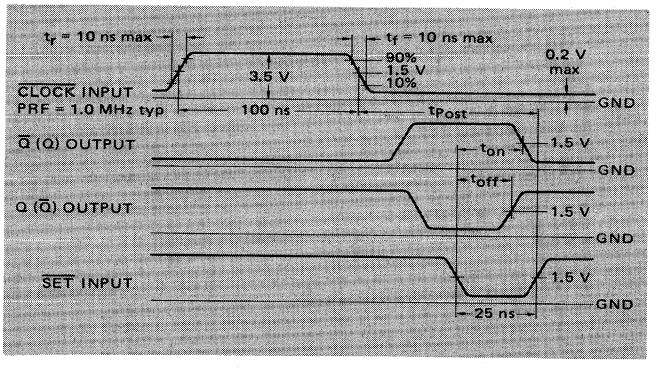
NOTES:
All transistors are MC511 (all emitters common) or equivalent
R_G = 50 ohms
C_L = 15 pF including stray capacitance capacitance
t_{Post} = Post Time

TEST PARAMETERS

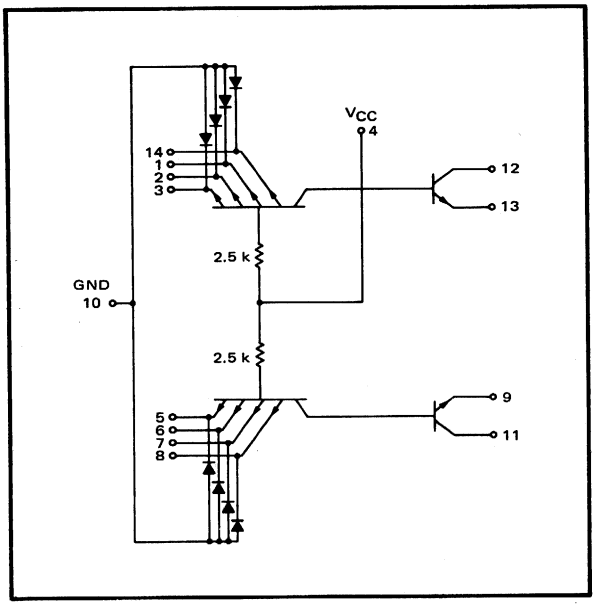
SYMBOL	VALUE	UNIT
t_{Post}	100	ns min
t_{on}	25	ns max
t_{off}	20	ns max

NOTE:
When t_{Post} is 100 ns, $\overline{SET}$ pulse must actuate the device. $\overline{SET}$ pulse cannot return to the high state before the required post time.

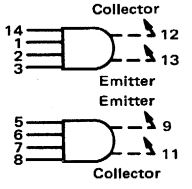
VOLTAGE WAVEFORMS AND DEFINITIONS



MC2106 • MC2156
MC2006 • MC2056



This device consists of two independent 4-input AND gates. The outputs of each gate are made available as ORing nodes. Using the MC2102 series and the MC2106 series with any one of the basic expandable gates, up to 10 AND gates can be ORed together.



Total Power Dissipation = 14 mW typ/Pkg.

Propagation Delay Times:

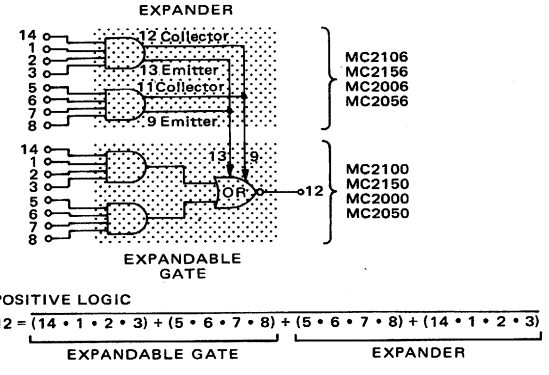
Δt_{pd} = +1.0 ns typ
When added to the expandable AND-OR-INVERT gates.

$\Delta t_{pd}/pF$ = +0.7 ns/pF typ
Caused by additional capacitance at expansion points.

SERIES	INPUT LOADING FACTOR	(I_F)	TEMPERATURE RANGE
MC2106 MC2156	1	−2.0 mA	−55°C to +125°C
MC2006 MC2056	1	−2.5 mA	0°C to +75°C

Full output loading factor of the expandable gate is maintained.

APPLICATION: EXPANDABLE 2-WIDE 4-INPUT, "AND-OR-INVERT" GATE WITH A DUAL 4-INPUT EXPANDER CONNECTED.

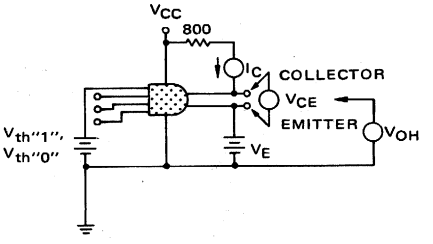


POSITIVE LOGIC

$12 = \overline{(14 \cdot 1 \cdot 2 \cdot 3) + (5 \cdot 6 \cdot 7 \cdot 8)} + (5 \cdot 6 \cdot 7 \cdot 8) + (14 \cdot 1 \cdot 2 \cdot 3)$

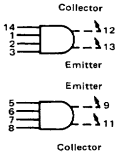
EXPANDABLE GATE | EXPANDER

V_{CE}, V_{OH} TEST CIRCUIT



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one expander. The other expander is tested in a similar manner. Further, test procedures are shown for only one input of the expander being tested. To complete testing, sequence through remaining inputs.



	@ Test Temperature	I_C (mA)	I_{in} (mA)	V_R (Volts)	V_{E1} (Volts)	V_{E2} (Volts)	V_{E3} (Volts)	$V_{th\,1}$ (Volts)	$V_{th\,0}$ (Volts)	V_{out} (Volts)	V_{CR} (Volts)	V_{CRH} (Volts)	V_{CC} (Volts)	V_{CCH} (Volts)
MC2106, MC2156	−55°C	6.0	1.0	4.5	1.00	0.90	0.8	2.0	0.9	5.5	*	-	5.0	-
	+25°C	6.0	1.0	4.5	0.85	0.75	0.8	1.7	1.1	5.5	*	**	5.0	8.0
	+125°C	6.0	1.0	4.5	0.65	0.55	0.8	1.4	0.9	5.5	*	-	5.0	-
MC2006, MC2056	0°C	6.0	1.0	4.5	0.90	0.80	0.8	1.9	1.0	5.5	*	-	5.0	-
	+25°C	6.0	1.0	4.5	0.85	0.75	0.8	1.8	1.1	5.5	*	**	5.0	7.0
	+75°C	6.0	1.0	4.5	0.75	0.65	0.8	1.7	1.0	5.5	*	-	5.0	-

Characteristic	Symbol	Pin Under Test	MC2106, MC2156 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2006, MC2056 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_C	I_{in}	V_R	V_{E1}	V_{E2}	V_{E3}	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CR}	V_{CRH}	V_{CC}	V_{CCH}	Gnd†
Input																												
Forward Current	I_F	1	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	2,3,14	-	-	-	-	-	-	-	-	4	-	1,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	1	-	-	-	-	-	-	-	-	4	-	2,3,10,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	1	13	-	-	-	-	-	12	-	4	-	10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	1	-	13	-	-	-	-	-	12	-	4	-	10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	1	-	-	-	-	-	-	-	-	-	4	-	2,3,10,14
Output																												
Output Voltage	V_{OH}	12	4.8	-	4.8	-	4.8	-	4.8	-	4.8	-	4.8	-	Vdc	-	-	-	-	13	-	-	1	-	12	-	4	-	10
	V_{CE} ①	12	-	0.65	-	0.65	-	0.65	-	0.65	-	0.65	-	0.65	Vdc	12	-	-	13	-	-	1	-	-	-	-	4	-	10
Leakage Current	I_{OLK}	12	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	13	-	-	12	-	-	4	-	1,2,3,10,14
Power Requirements (Total Device)																												
Maximum Power Supply Current	I_{max} ②	4	-	-	-	7.0	-	-	-	-	-	7.5	-	-	mAdc	-	-	-	-	-	9,13	-	-	-	-	11,12	-	4	1,2,3,10,14
Power Supply Drain	I_{PDH}	4	-	3.0	-	3.0	-	3.0	-	3.6	-	3.6	-	3.6	mAdc	-	-	-	-	-	9,13	-	-	-	-	-	4	-	10‡
	I_{PDL}	4	-	4.25	-	4.25	-	4.25	-	5.25	-	5.25	-	5.25	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3,10,14

* Indicated pins tied to V_{CC} thru 800 ohms ± 1.0% resistor.

** Indicated pins tied to V_{CCH} thru 800 ohms ± 1.0% resistor.

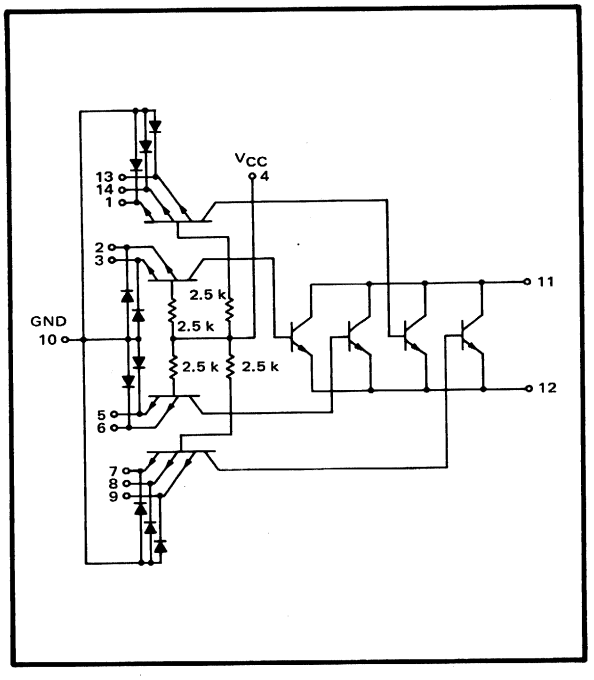
† Ground inputs to gate not under test during ALL tests, unless otherwise noted.

‡ The inputs of both gates must be ungrounded.

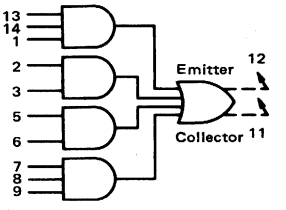
① V_{CE} is referenced to the emitter voltage (Pin 13). The other gate is referenced to (Pin 9).

② Pin 9 ties to Pin 13. Pin 12 ties to Pin 11.

MC2102 • MC2152
MC2002 • MC2052



This device consists of two 2-input and two 3-input AND gates ORed together with the common ORing nodes made available as the output. The basic expandable gate can be expanded up to 10 AND gates by using the MC2102 series or the MC2106 series expander package.



Total Power Dissipation = 28 mW typ/Pkg.

Propagation Delay Times:

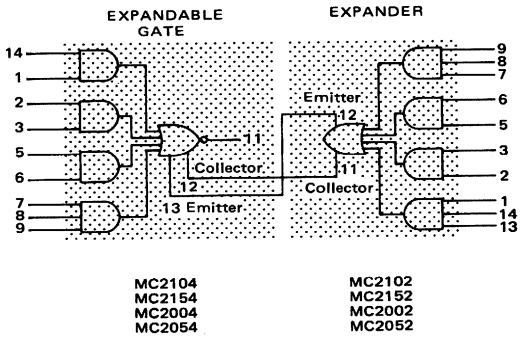
Δt_{pd} = +2.0 ns typ
When added to the expandable AND-OR-INVERT gates.

$\Delta t_{pd}/pF$ = +0.7 ns/pF typ
Caused by additional capacitance at expansion points.

SERIES	INPUT LOADING FACTOR	(I_F)	TEMPERATURE RANGE
MC2102 MC2152	1	−2.0 mA	−55°C to +125°C
MC2002 MC2052	1	−2.5 mA	0°C to +75°C

Full output loading factor of the expandable gate is maintained.

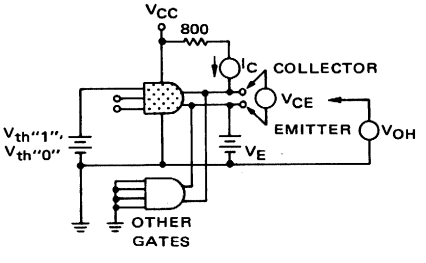
APPLICATION: EXPANDABLE 4-WIDE "AND-OR-INVERT" GATE WITH A 4-WIDE 3-2-2-3 INPUT EXPANDER CONNECTED.



MC2104
MC2154
MC2004
MC2054

MC2102
MC2152
MC2002
MC2052

V_{CE}, V_{OH} TEST CIRCUIT

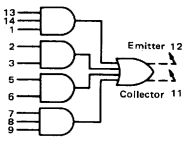


EXPANDER (MC2102)
POSITIVE LOGIC

$$11 = \underbrace{(13 \cdot 14 \cdot 1) + (2 \cdot 3) + (5 \cdot 6) + (7 \cdot 8 \cdot 9)}_{\text{EXPANDER}} + \underbrace{(14 \cdot 1) + (2 \cdot 3) + (5 \cdot 6) + (7 \cdot 8 \cdot 9)}_{\text{EXPANDABLE GATE}}$$

ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input of the device. To complete testing, sequence through remaining inputs in the same manner.



@ Test Temperature		TEST CONDITIONS												
		mA		Volts										
		I_C	I_{in}	V_R	V_{E1}	V_{E2}	V_{E3}	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CR}	V_{CRH}	V_{CC}	V_{CCH}
MC2102 , MC2152	−55°C	6.0	1.0	4.5	1.00	0.90	0.8	2.0	0.9	5.5	*	-	5.0	-
	+25°C	6.0	1.0	4.5	0.85	0.75	0.8	1.7	1.1	5.5	*	**	5.0	8.0
	+125°C	6.0	1.0	4.5	0.65	0.55	0.8	1.4	0.9	5.5	*	-	5.0	-
MC2002 , MC2052	0°C	6.0	1.0	4.5	0.90	0.80	0.8	1.9	1.0	5.5	*	-	5.0	-
	+25°C	6.0	1.0	4.5	0.85	0.75	0.8	1.8	1.1	5.5	*	**	5.0	7.0
	+75°C	6.0	1.0	4.5	0.75	0.65	0.8	1.7	1.0	5.5	*	-	5.0	-

Characteristic	Symbol	Pin Under Test	MC2102, MC2152 Test Limits −55°C Min	−55°C Max	+25°C Min	+25°C Max	+125°C Min	+125°C Max	MC2002, MC2052 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_C	I_{in}	V_R	V_{E1}	V_{E2}	V_{E3}	$V_{th\,1}$	$V_{th\,0}$	V_{out}	V_{CR}	V_{CRH}	V_{CC}	V_{CCH}	Gnd
Input																													
Forward Current	I_F	1	-	-2.0	-	-2.0	-	-2.0	-	-2.5	-	-2.5	-	-2.5	mAdc	-	-	2,3,5,6,7, 8,9,13,14	-	-	-	-	-	-	-	-	4	-	1,10
Leakage Current	I_R	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	1	-	-	-	-	-	-	-	-	4	-	2,3,5,6,7,8, 9,10,13,14
Inverse Beta Current	I_L	1	-	100	-	100	-	100	-	100	-	100	-	100	μAdc	-	-	1	12	-	-	-	-	-	11	-	4	-	2,3,5,6,7,8,9,10
Breakdown Voltage	BV_{in} "0"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	1	-	12	-	-	-	-	-	11	-	4	-	2,3,5,6,7,8,9,10
	BV_{in} "1"	1	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	5.5	-	Vdc	-	1	-	-	-	-	-	-	-	-	-	4	-	2,3,5,6,7,8,9, 10,13,14
Output																													
Output Voltage	V_{OH}	11	4.8	-	4.8	-	4.8	-	4.8	-	4.8	-	4.8	-	Vdc	-	-	-	-	12	-	-	1	-	11	-	4	-	2,3,5,6,7,8,9,10
	V_{CE} ①	11	-	0.65	-	0.65	-	0.65	-	0.65	-	0.65	-	0.65	Vdc	11	-	-	12	-	-	1	-	-	-	-	4	-	2,3,5,6,7,8,9,10
Leakage Current	I_{OLK}	11	-	250	-	250	-	250	-	250	-	250	-	250	μAdc	-	-	-	-	-	12	-	-	11	-	-	4	-	1,2,3,5,6,7,8, 9,10,13,14
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	4	-	-	-	14	-	-	-	-	-	15	-	-	mAdc	-	-	-	-	-	12	-	-	-	-	11	-	4	1,2,3,5,6,7,8, 9,10,13,14
Power Supply Drain	I_{PDH}	4	-	6.0	-	6.0	-	6.0	-	7.2	-	7.2	-	7.2	mAdc	-	-	-	-	-	12	-	-	-	-	-	4	-	10
	I_{PDL}	4	-	8.5	-	8.5	-	8.5	-	10.5	-	10.5	-	10.5	mAdc	-	-	-	-	-	-	-	-	-	-	-	4	-	1,2,3,5,6,7,8, 9,10,13,14

* Indicated pins tied to V_{CC} thru 800 ohms ± 1.0% resistor.
** Indicated pins tied to V_{CCH} thru 800 ohms ± 1.0% resistor.
① V_{CE} is referenced to the emitter Voltage (Pin 12).

MTTL III

INTEGRATED CIRCUITS

MC3000 SERIES

MTTL III

INTEGRATED CIRCUITS

INDEX

NUMERICAL INDEX
(Functions and Characteristics)

V_{CC} = 5.0 V, T_A = 25°C

Function	Type	Output Loading Factor Each Output	Propagation Delay t_{pd} ns typ	Power Dissipation mW typ/pkg	Page No.
Quad 2-Input NAND Gate	MC3000	10	6.0	88	4-112
Quad 2-Input AND Gate	MC3001	10	9.0	112	4-110
Quad 2-Input NOR Gate	MC3002	10	6.0	122	4-114
Quad 2-Input OR Gate	MC3003	10	9.0	150	4-116
Triple 3-Input NAND Gate	MC3005	10	6.0	66	4-108
Dual 4-Input NAND Gate	MC3010	10	6.0	44	4-104
Single 8-Input NAND Gate	MC3015	10	8.0	22	4-102
Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate	MC3020	10	6.0	62.5	4-106
Dual 4-Input NAND Power Gate	MC3025	20	6.0	70	4-120
Dual 4-Input AND Power Gate	MC3026	20	9.0	90	4-118
Dual 3-Input 3-Output AND Series Terminated Line Driver	MC3028	*	9.0	56	4-124
Dual 3-Input 3-Output NAND Series Terminated Line Driver	MC3029	*	6.0	44	4-126
Dual 4-Input Expander for AND-OR-INVERT Gates	MC3030	**	***	15	4-122
AND J-K Flip-Flops	MC3050	10	f = 40 MHz	80	4-128
AND Input $J\bar{J}$-$K\bar{K}$ Flip-Flop	MC3052	10	f = 40 MHz	75	4-133
Dual Type D Flip-Flop	MC3060	10	f = 30 MHz	120	4-138
Dual J-K Flip-Flop	MC3061	10	f = 50 MHz	100	4-141
Dual J-K Flip-Flop	MC3062	10	f = 50 MHz	100	4-145

*Direct Output = 10 minus the number of resistor-terminated outputs being used.

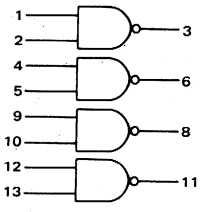
**Full output loading factor of the expandable gate is maintained.

***Δt_{pd} = +1.0 ns typ when added to the expandable AND-OR-INVERT Gate.

Δt_{pd}/pF = +1.0 ns pF typ caused by additional capacitance at expansion points.

GATES

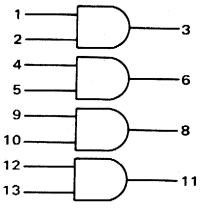
MC3000
Quad 2-Input NAND Gate



$3 = \overline{1 \cdot 2}$

t_{pd} = 6.0 ns typ
P_D = 88 mW typ/pkg

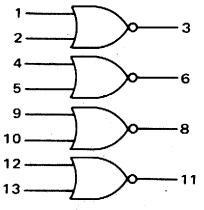
MC3001
Quad 2-Input AND Gate



$3 = 1 \cdot 2$

t_{pd} = 9.0 ns typ
P_D = 112 mW typ/pkg

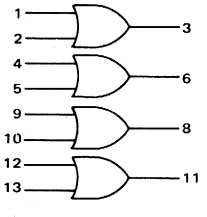
MC3002
Quad 2-Input NOR Gate



$3 = \overline{1 + 2}$

t_{pd} = 6.0 ns typ
P_D = 122 mW typ/pkg

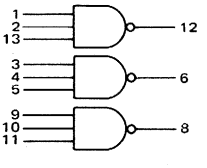
MC3003
Quad 2-Input OR Gate



$3 = 1 + 2$

t_{pd} = 9.0 ns typ
P_D = 150 mW typ/pkg

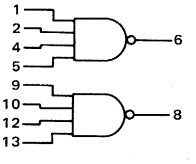
MC3005
Triple 3-Input NAND Gate



$12 = \overline{1 \cdot 2 \cdot 13}$

t_{pd} = 6.0 ns typ
P_D = 66 mW typ/pkg

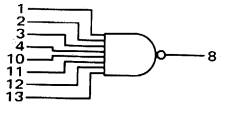
MC3010
Dual 4-Input NAND Gate



$6 = \overline{1 \cdot 2 \cdot 4 \cdot 5}$

t_{pd} = 6.0 ns typ
P_D = 44 mW typ/pkg

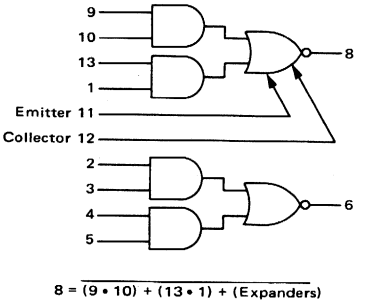
MC3015
Single 8-Input NAND Gate



$8 = \overline{1 \cdot 2 \cdot 3 \cdot 4 \cdot 10 \cdot 11 \cdot 12 \cdot 13}$

t_{pd} = 8.0 ns typ
P_D = 22 mW typ/pkg

MC3020
Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate



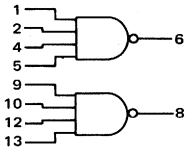
$8 = \overline{(9 \cdot 10) + (13 \cdot 1) + (\text{Expanders})}$

t_{pd} = 6.0 ns typ
P_D = 62.5 mW typ/pkg

LOGIC DIAGRAMS (continued)

POWER GATES

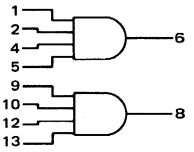
MC3025
Dual 4-Input NAND Power Gate



$6 = \overline{1 \cdot 2 \cdot 4 \cdot 5}$

t_{pd} = 6.0 ns typ
P_D = 70 mW typ/pkg

MC3026
Dual 4-Input AND Power Gate

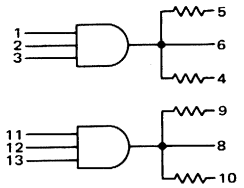


$6 = 1 \cdot 2 \cdot 4 \cdot 5$

t_{pd} = 9.0 ns typ
P_D = 90 mW typ/pkg

LINE DRIVERS

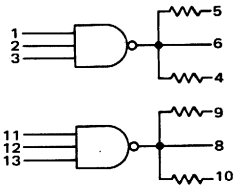
MC3028
Dual 3-Input 3-Output AND
Series Terminated Line Driver



4, 5, 6, = 1 • 2 • 3

t_{pd} = 9.0 ns typ
P_D = 56 mW typ/pkg

MC3029
Dual 3-Input 3-Output NAND
Series Terminated Line Driver

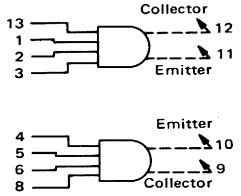


$4, 5, 6 = \overline{1 \cdot 2 \cdot 3}$

t_{pd} = 6.0 ns typ
P_D = 44 mW typ/pkg

EXPANDER

MC3030
Dual 4-Input Expander for
AND-OR-INVERT Gates



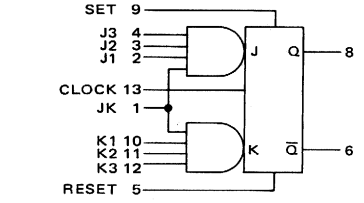
Δt_{pd} = +1.0 ns typ
When added to the expandable "AND-OR-INVERT" gate.

$\Delta t_{pd}/pF$ = +1.0 ns pF typ
Caused by additional capacitance at expansion points.

P_D = 15 mW typ/pkg

FLIP-FLOPS

MC3050
AND J-K Flip-Flop

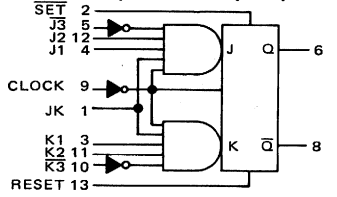


J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Where:
$J = J1 \cdot J2 \cdot J3 \cdot JK$
$K = K1 \cdot K2 \cdot K3 \cdot JK$

f = 40 MHz
P_D = 80 mW typ/pkg

MC3052
AND Input $J\overline{J}$-$K\overline{K}$ Flip-Flop

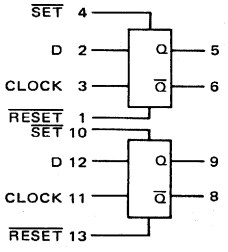


J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Where:
$J = J1 \cdot J2 \cdot \overline{J3} \cdot JK$
$K = K1 \cdot K2 \cdot \overline{K3} \cdot JK$

f = 40 MHz
P_D = 75 mW typ/pkg

MC3060
Dual Type D Flip-Flop

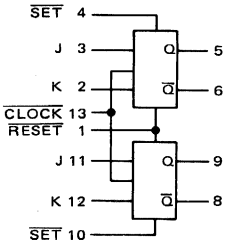


D	Q_n	Q_{n+1}
0	0	0
0	1	0
1	0	1
1	1	1

$Q_{n+1} = D_n$

f = 30 MHz
P_D = 120 mW typ/pkg

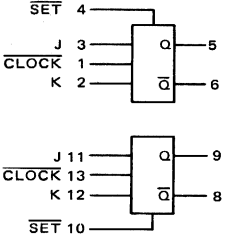
MC3061
Dual J-K Flip-Flop



J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

f = 50 MHz
P_D = 100 mW typ/pkg

MC3062
Dual J-K Flip-Flop



J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

f = 50 MHz
P_D = 100 mW typ/pkg

MTTL III

GENERAL INFORMATION SECTION

INTRODUCTION

MTTL III integrated circuits are designed with speed approaching the limit for saturated logic and for good load driving capability. This line includes all the characteristics that have made transistor-transistor logic so popular. The major advantage of MTTL III over other TTL lines is the square transfer characteristic (Figure 1) that exists only for the MTTL III family. Because of this "ideal" transfer characteristic, the MTTL III family is the only TTL line that is truly compatible with MDTL. Another advantage of this family over competitive TTL lines is that it is designed to minimize problems associated with ringing.

The circuits in the MTTL III family are distinguished by a multiple-emitter input transistor, a darlington active "pull-up" in the upper output network, and an active bypass network in the base of the output pull-down transistor as shown in Figure 2.

The multiple-emitter input configuration offers the maximum logic capability in the minimum physical area and provides improved switching characteristics during turnoff. Clamp diodes are provided at each of the inputs to limit undershoot that occurs in typical system applications such as driving long interconnect wiring. The Darlington output configuration provides very low output impedances in each of the two output states. These low impedances result in excellent ac noise immunity and allows high-speed operation while driving large capacitive loads.

The active bypass shown in the dotted area of Figure 2 holds the phase inverter transistor "off" until gate threshold is reached. This circuit operation provides the squared transfer characteristic shown in Figure 1.

In addition to improving the transfer characteristic, the bypass network offers a number of advantages compared to a simple resistor that can be traced to a much smaller impedance variation with temperature.

1. *Lower bypass impedance for the reverse current of the output transistor at elevated temperatures, provides faster turn-off.*
2. *A lower current spike during the turn-off transient causes a lower ac power factor resulting in a lower total power consumption. This advantage is even more pronounced at higher temperatures.*
3. *Faster turn-on at low temperature.*

FIGURE 1 – COMPARISON OF CONVENTIONAL TRANSISTOR-TRANSISTOR LOGIC AND MTTL III

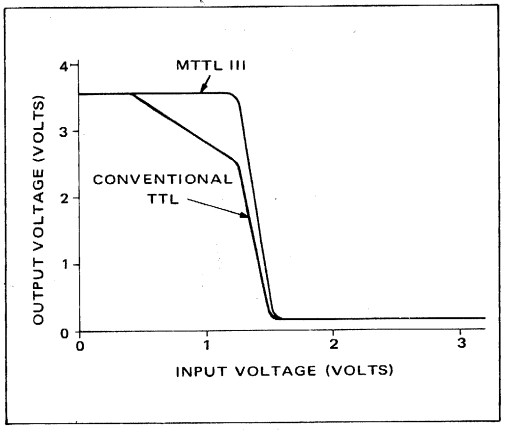
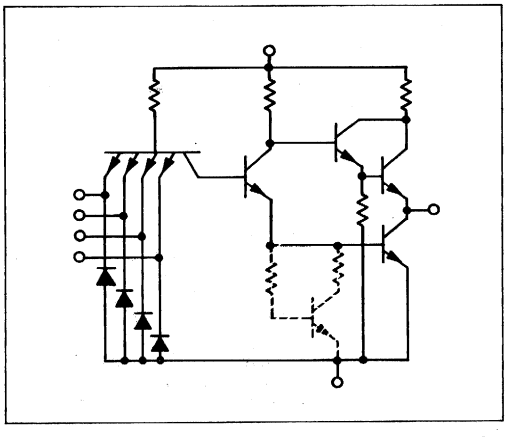


FIGURE 2 – TYPICAL MTTL III CIRCUIT



TYPICAL CHARACTERISTICS

Typical operating characteristics of the MTTL III family include: (Unless otherwise indicated, the parameters are defined for V_{CC} = +5.0 volts and T_A = +25°C.)

- Supply Voltage Operating Range = 4.5 to 5.5 volts
- Operating Temperature Range: MC3000 Series
  0 to +75°C
- Output Drive Capability
  Gates (Output Loading Factor):
  MC3000 Series = 10 Gates.
  Capacitance = 600 pF
- Output Impedance
  High State = 10 ohms nominal (unsaturated)
  Low State = 10 ohms nominal
- Output Voltage Swing = 0.2 to 3.5 volts typical
- Input Voltage Limits
  +5.5 volts maximum
  −1.5 volts minimum (1)
- Switching Threshold = 1.5 volts nominal
- Input Impedance
  High State = 400 k ohms nominal
  Low State = 2.4 k ohms nominal
- Worst-Case dc Noise Margin
  High State = 0.700 volt minimum
  Low State = 0.700 volt minimum
- Power Dissipation
  22 mW per gate typical
  50-80 mW per flip-flop typical
- Switching Speeds (2)
  Average Propagation Delay = 6.0 ns per gate typical
  13 ns per flip-flop typical
  Rise Time = 1.0 ns typical
  Fall Time = 1.3 ns typical
- Flip-Flop Clock Frequency (MC3061) = 50 MHz maximum.

"NAND" GATES

The basic gate of the MTTL III logic family is the positive logic NAND gate. This gate is characterized by high speed, good load driving capability, superior transfer characteristic, and freedom from ringing problems. Representative of the various NAND gates presently available in the MTTL III family is the 4-input NAND gate (½ of the MC3010) shown in Figure 3.

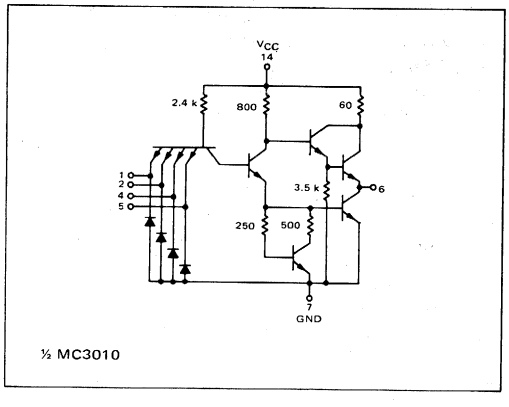
"AND" GATES

While it is possible to design a complete logic system with NAND logic, it is often desirable to use other logic forms to save circuits, power dissipation, and propagation delay. Therefore, the positive logic AND function has been added to the MTTL III family.

Examples of the AND function are the standard quad 2-input gate, dual 4-input gate, dual 4-input power gate and a dual 3-input, 3-output line driver.

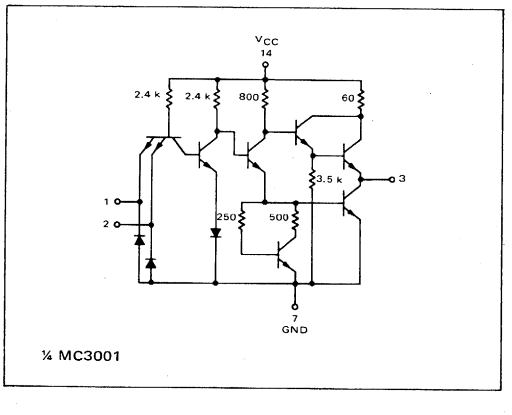
The technique used to form the AND function is the addition of an inverter to the basic NAND circuit. As shown in Figure 4, the inverter transistor with a collector resistor and an offset diode connected to its emitter is inserted between the multiple-emitter input transistor and the basic circuit phase-splitter transistor. The extra inversion adds only 3.0 ns propagation delay and about 6.0 mW additional power dissipation.

FIGURE 3 – MTTL III POSITIVE LOGIC "NAND" GATE CIRCUIT



½ MC3010

FIGURE 4 – MTTL III POSITIVE LOGIC "AND" GATE CIRCUIT



¼ MC3001

(1) Assuming unused inputs are returned to voltage not greater than 4.0 Vdc.

(2) The switching characteristics of the MTTL III family are defined with respect to the associated transitions of the voltage waveforms. The average propagation delay is defined as the average of the turn-on delay and the turn-off delay measured from the 1.5 V point of the input to the 1.5 V point of the associated output transition or:

$$t_{pd} = \frac{t_{on} + t_{off}}{2} \text{ ns}$$

Rise time is defined as the positive going transition of the output from the 1.0 V to the 2.0 V level. Fall time is defined as the negative output transition from the 2.0 V to the 1.0 V level.

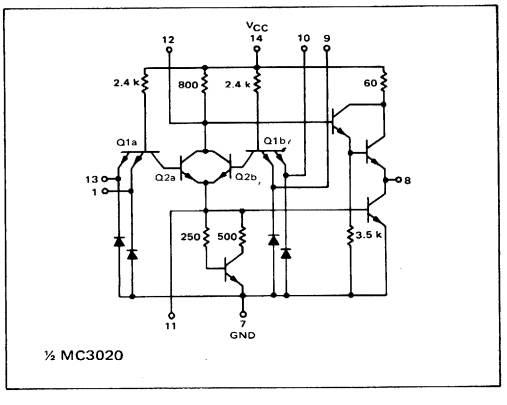
"AND-OR-INVERT" GATES

Unlike the MDTL family of logic circuits, the outputs of MTTL logic circuits cannot be tied together to perform the "Implied AND", often called the "Wired OR" function. If the outputs of the MTTL family devices are tied together, the lower output transistor of one circuit and the upper output transistor of another circuit can be "on" simultaneously. This condition provides a low-impedance path from V_{CC} to ground, and due to excessive current flow, the saturated output state cannot be maintained and the desired logic function is not satisfied.

To retain the logical advantages offered by the "Implied AND" with the speed and load driving capability of an active pull-up, the MTTL III family offers an AND-OR-INVERT Gate. The gate in Figure 5 incorporates two 2-input AND functions with outputs that are ORed and inverted. The AND function is provided by two multiple-emitter input transistors (Q1a and Q1b). The OR and INVERT operation is accomplished by two paralleled transistors (Q2a and Q2b) sharing a single collector resistor and a single bypass network. These paralleled transistors in turn drive the standard output.

The common collector and emitter nodes of one gate in each package are available externally to permit expansion.

FIGURE 5 – MTTL III "AND-OR-INVERT" GATE CIRCUIT



EXPANDER AND EXPANDER NODES

The ORing nodes of ½ the MC3020 dual AND-OR-INVERT Gate (Figure 5) are available for expanding the number of AND gates to four. Since these are comparatively high-impedance nodes, care should be taken to minimize capacitive loading on the expander terminals if switching speed is to be maintained. When an expander is to be used with an expandable AND-OR-INVERT gate, it should be placed as close as possible to the gate being expanded. The increase in the average propagation delay per AND gate added to an expandable AND-OR-INVERT gate is typically 1.0 ns/AND gate. The increase in average propagation delay as a function of capacitance added to the expander nodes is typically 1.0 ns/pF.

"NOR" GATES

To save inverters, the system designer often needs the positive logic NOR function as well as the negative logic NOR available with the standard NAND gate. This capability is incorporated in the MTTL III line in the form of the MC3002, quad 2-input NOR Gate. The NOR gate is a modified AND-OR-INVERT gate with only a single emitter on each input transistor, as shown in Figure 6.

"OR" GATES

To provide the system designer with still another tool for optimum design, the MTTL III Series also offers the positive logic OR function. As shown in Figure 7, the OR is essentially a NOR gate with an additional inverter.

POWER GATES

Standard MTTL III gates offer good load driving capability and high fan-out. In most systems, however, there are a few applications that exceed the capability of a standard gate. The MTTL III power gates, shown in Figure 8, are designed to meet these requirements with a minimum of additional circuitry. Available in both NAND and AND functions, the power gates feature output circuitry designed to provide twice the fan-out of conventional gates: 20 standard gate loads instead of 10.

FIGURE 6 – MTTL III POSITIVE LOGIC "NOR" GATE CIRCUIT

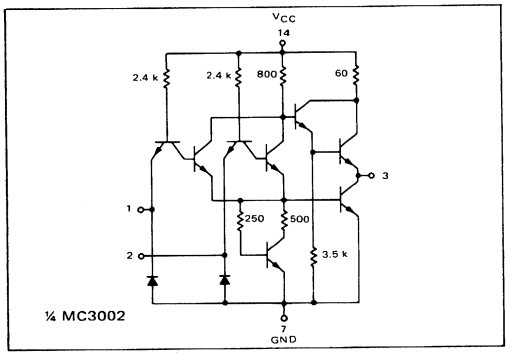
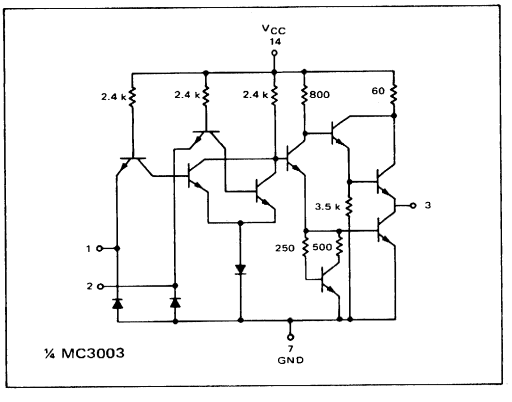


FIGURE 7 – MTTL III POSITIVE LOGIC "OR" GATE CIRCUIT



LINE DRIVERS

To minimize switching transients on long lines, the MTTL III family includes dual 3-input/3-output series-terminated line drivers. Two outputs have 75-ohm resistors in series with the standard output node, and one is connected directly to the node. A good match can be made at the output of each resistor when driving 93-ohm coax or 120-ohm twisted pair. For loads of 50 to 93 ohms, the two resistive outputs are paralleled for impedance matching. The non-resistive output can be used to drive adjacent loads in a normal fashion. The total number of output loads connected to the direct output (non-resistive output) is the standard fan-out of 10, minus the number of resistor terminated outputs being used.

Figure 9 shows 1/2 of the circuit of the MC3029, dual 3-input, 3-output series terminated NAND line driver. Figure 10 shows a typical application of this circuit and Figure 11 demonstrates the effects of series termination without a significant loss in high state noise immunity.

FIGURE 8 – MTTL III POWER GATE CIRCUIT (AND)

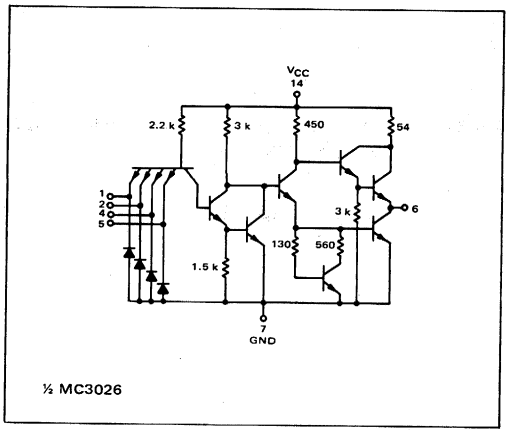


FIGURE 9 – MTTL III TERMINATED LINE DRIVER (NAND)

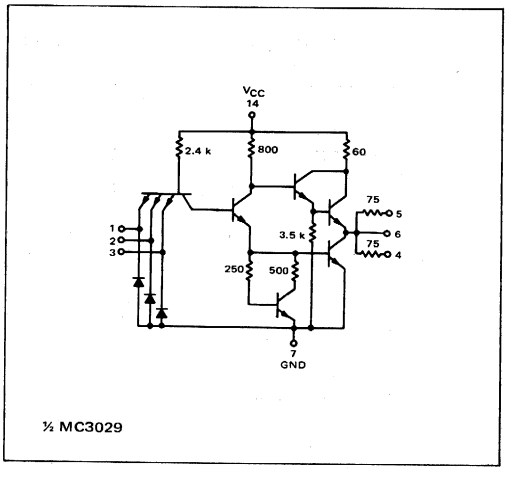


FIGURE 10 – TYPICAL APPLICATION OF THE LINE DRIVER

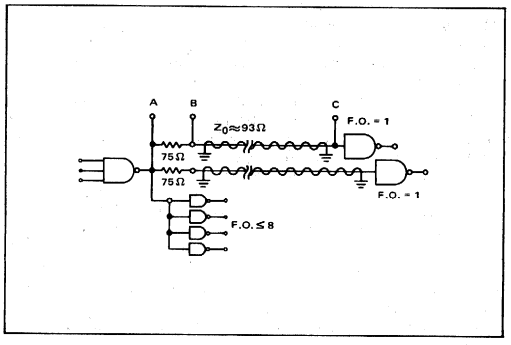
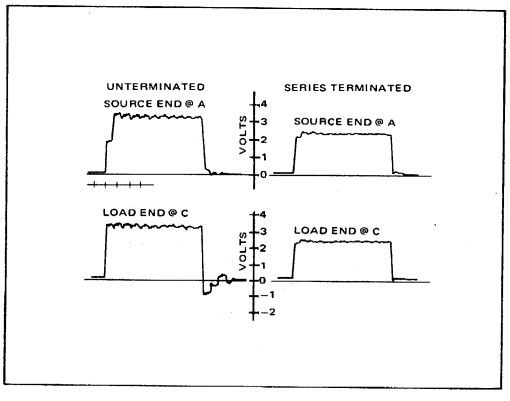


FIGURE 11 – EFFECTS OF SERIES TERMINATION WITH A MTTL III GATE DRIVING A 93-OHM LINE



OPERATING CHARACTERISTICS OF FLIP-FLOPS

The cornerstone of any modern logic family is the capability of its storage elements. The MTTL III flip-flops are designed to give maximum logic performance with fewer system restrictions than their predecessors. Three basic designs are typified by the MC3050, MC3060 and MC3061/MC3062. Common to all designs are:

1. Edge clocking.

   The flip-flop is clocked at the normal MTTL III threshold voltage (approximately 1.5 V @ 25°C).

2. Overriding asynchronous inputs.

   The direct SET and RESET inputs control the operation of the flip-flop regardless of the state of the clock or the information on synchronous inputs.

3. Short set-up times.

   Prior to the clocking edge, the input information must become stable. The MTTL III flip-flops require only a minimum of time to read a "1" or a "0". Therefore data may be applied anytime in the clock period except during the time interval between the Set-up and Hold times. This characteristic permits higher clock frequencies or eliminates the necessity for critical control of clock pulse width.

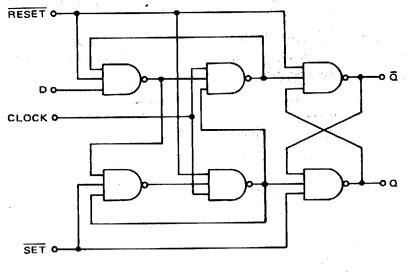
4. All inputs to the storage elements including the clock input have inputs that are compatible with all three MTTL families.

The MC3050 and MC3060 flip-flops are positive edge triggered storage elements. That is, the inputs are enabled on the negative edge of the clock and the information is stored in the flip-flop on the positive edge of the clock. The MC3061 and MC3062 dual flip-flops are negative edge triggered devices and therefore operate in precisely the opposite manner. That is, data is stored on the negative edge of the clock.

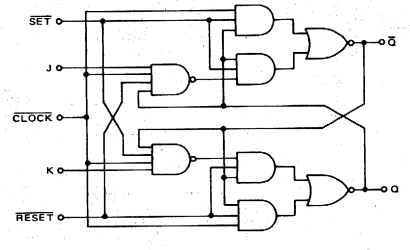
In addition to the previously mentioned storage elements. The MC3052 Master-Slave flip-flop is also available. Data is stored in the Master flip-flop when the clock is low and transferred to the Slave flip-flop when the clock goes high.

Detailed discussion of each of the MTTL III flip-flops is provided on the individual data sheets.

FIGURE 12 – LOGIC DIAGRAMS OF EDGE-CLOCKED MTTL III FLIP-FLOPS

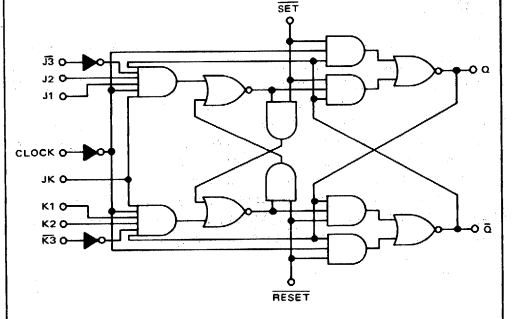


MC3060

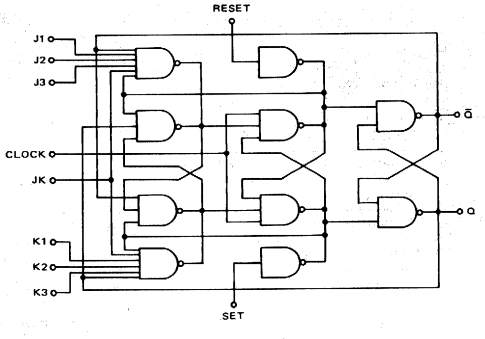


MC3061

FIGURE 13 – LOGIC DIAGRAM OF MTTL III MASTER-SLAVE J-K FLIP-FLOP



MC3052



MC3050

BREADBOARDING SUGGESTIONS

When breadboarding with any form of high-speed, high-performance TTL circuit, the designer must always be aware of the problems caused by very high switching speeds. These switching speeds, especially the frequencies associated with the very fast rise and fall times of the circuits, are in the upper RF range and good high-frequency layout techniques should be used. The following breadboarding suggestions will help the designer in his initial circuit layout. In many cases the breadboarding suggestions will have to be modified to meet the requirements of the designer's specific application.

Power and Ground Distribution

Special care should be taken to insure adequate distribution of power and ground systems. The typical rates of change of current and voltage for a single MTTL III gate are in the range of 10^7 A/s and 10^8 V/s respectively. These figures reflect the necessity for a low-impedance power supply and ground distribution system, if transients are to be minimized and noise margins maintained. The use of AWG No. 20 wire or larger is often required. For printed circuitry, line widths of 100 mils or more are often necessary. A ground plane is desirable when using a large number of units.

Bypassing

To reduce supply transients, the breadboard should be bypassed at the point where power is supplied to the board and at intervals throughout the board. The use of a single bypass capacitor at the output terminal of the power supply is not adequate in a breadboard utilizing the fast rise and fall time MTTL III circuits. A comparatively large, low-inductance type capacitor (in the 1.0 μF range) is suggested at the point where power and ground enter the board. In many cases it has been found that distributing 0.01 μF capacitors for every five packages throughout a breadboard is adequate to suppress normal switching transients. It is also suggested that a bypass capacitor be placed in close proximity to any circuit driving a large capacitive load.

Power Dissipation

The typical average dc power dissipation is given for each MTTL III device (3). It should be noted that the totem-pole output common to all high-level MTTL circuits has an associated ac power dissipation factor. This factor results from the timing overlap of the upper and lower output transistors during the normal switching operation and is typically 0.4 mW/MHz/output for a 15-pF load. This ac power dissipation should be added when calculating the total power requirements of the MTTL III circuits.

Unused Inputs and Unused Gates

To minimize potential problems resulting from external noise, the unused inputs of any MTTL III logic circuit should not be left open, but should either be tied to the used inputs or returned to a voltage between 2.0 and 5.5 Vdc. (For flip-flops, see appropriate data sheet for additional detail.) If the unused inputs are returned to a voltage, care should be exercised to insure that the absolute voltage between the most negative input level and that voltage does not exceed +5.5 volts. The total number of inputs that can be tied to the output of any driving gate is 25. (This is defined as high-state output loading factor.) It should be noted that the low-state output loading rules must still be maintained. The minimum logical "1" level for the high-state output loading is summarized for V_{CC} = 5.0 V, V_{IL} = 1.1 V, and I_{OH} = -2.0 mA: V_{OH} = 2.5 volts minimum @ 0°C.

To minimize power drain, the inputs of any unused gate in a package should be maintained at the level that would place the outputs in the high state (the low power dissipation state).

---

(3) $$P_D = \frac{I_{PDL} + I_{PDH}}{2} (V_{CC})$$

where I_{PDL} and I_{PDH} are the typical current drains at V_{CC} = +5.0 V.

MAXIMUM RATINGS

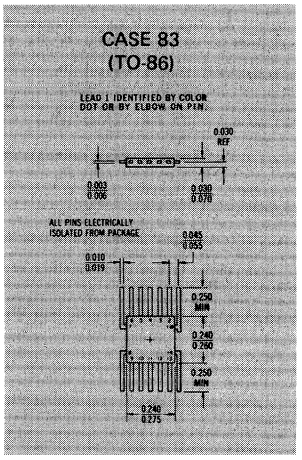
Rating	Value	Unit
Supply Voltage — Continuous	+7.0	Vdc
Supply Operating Voltage Range	4.5 to 5.5	Vdc
Input Voltage	+5.5	Vdc
Output Voltage	+5.5	Vdc
Operating Temperature Range	0 to +75	°C
Storage Temperature Range — Flat Package Plastic Package	−65 to +175 −55 to +125	°C °C

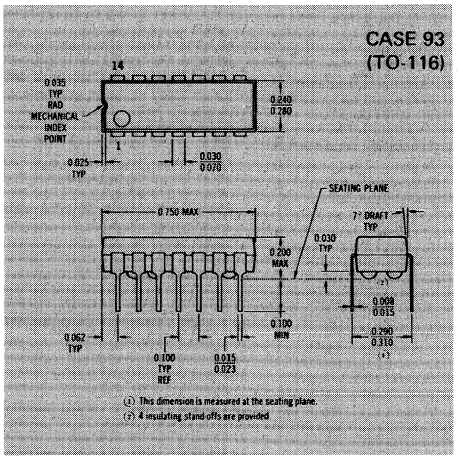
DEFINITIONS

BV_{in}	Input breakdown voltage
C_T	Total parasitic capacitance, which includes probe, wiring, and load capacitances
I_C	Collector current
I_{CO}	Expander collector leakage current
I_D	Input diode current with negative voltage applied
I_E	Emitter current
I_{EO}	Expander emitter leakage current
I_{EXE}	Expander drive current at emitter node of AND-OR-INVERT gate
I_F	Input forward current with V_{CC} applied
I_{F1}	Input forward current with V_{CCL} applied
I_{F2}	Input forward current with V_{CCH} applied
I_{FC}	Clock input forward current
I_{FD}	D input forward current
I_{FJ}	J input forward current
I_{FK}	K input forward current
I_{FJK}	JK input forward current
I_{FR}	RESET input forward current
I_{FS}	SET input forward current
I_{in}	Input current
I_{max}	Maximum rated power supply current with V_{max} applied
I_{OH}	Output high state current
I_{OHA}	Unterminated output high state current
$I_{OHB, C}$	Terminated output high state current
I_{OL}	Output low state current
I_{OL1}	Output low state current with V_{CCL} applied
I_{OL1A}	Unterminated output low state current with V_{CCL} applied
I_{OL2}	Output low state current with V_{CCH} applied
I_{OL2A}	Unterminated output low state current with V_{CCH} applied
$I_{OL1B, 1C}$	Terminated output low state current with V_{CCL} applied
$I_{OL2A, 2C}$	Terminated output low state current with V_{CCH} applied
I_{PD}	Flip-flop power supply drain current
I_{PDH}	Power supply drain with inputs high
I_{PDL}	Power supply drain with inputs low
I_R	Input leakage current
I_{RC}	Clock input leakage current
I_{RD}	D input leakage current
I_{RJ}	J input leakage current
I_{RK}	K input leakage current
I_{RJK}	JK input leakage current
I_{RR}	RESET input leakage current
I_{RS}	SET input leakage current
I_{SC}	Short-circuit current
P_1	Pulse used to set flip-flop state
PRF	Pulse repetition frequency
PW	Pulse width
t_f	Fall time
$t_{Hold\ "0"}$	Minimum time that low state data must be maintained after the clocking edge
$t_{Hold\ "1"}$	Minimum time that high state data must be maintained after the clocking edge
Δt_{pd}	Average increase in propagation delay per expander AND gate when connected to an AND-OR-INVERT gate
$\Delta t_{pd}/pF$	Increased propagation delay caused by additional capacitance at expansion points
$t_{pd\ "0"}$	Turn-on delay
$t_{pd\ "1"}$	Turn-off delay
t_r	Rise time
$t_{sd\ "0"}$	Turn-on delay from asynchronous input
$t_{sd\ "1"}$	Turn-off delay from asynchronous input
$t_{Set\ "0"}$	Minimum time that low state data must be applied prior to the clocking edge
$t_{Set\ "1"}$	Minimum time that high state data must be applied prior to the clocking edge
TP_{in}	Test point at input of device under test
TP_{out}	Test point at output of device under test
$V_{BE\ max}$	Emitter node threshold voltage for logic "0" output level
$V_{BE\ min}$	Emitter node threshold voltage for logic "1" output level
V_{CC}	Power supply voltage
V_{CCH}	High power supply voltage
V_{CCL}	Low power supply voltage
V_D	Diode clamp voltage
V_{EE1}	Voltage applied to expander emitter for V_{OL} test
V_{EE2}	Voltage applied to expander emitter node for I_{CO} test
V_F	Maximum logic "0" level output voltage
V_{IH}	Logic "1" threshold voltage
V_{IHX}	Reduced supply voltage to hold input above threshold and to prevent noise from entering the device
V_{IL}	Logic "0" threshold voltage
V_{max}	Maximum rated power supply voltage
V_{OH}	Output high voltage with I_{OH} source current
V_{OL}	Output low voltage with I_{OL} source current
V_{OL1}	Maximum output low voltage with V_{CCL} applied
V_{OL2}	Maximum output low voltage with V_{CCH} applied
V_{OL3}	Maximum output low voltage on terminated output with V_{CCL} applied
V_{OL4}	Maximum output low voltage on terminated output with V_{CCH} applied
V_R	Logic "1" minimum reverse voltage
V_{RH}	Logic "1" maximum reverse voltage

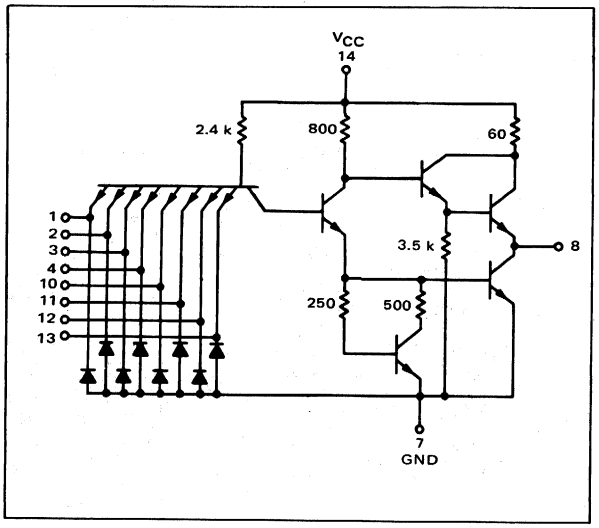
PACKAGING

All MTTL III integrated circuits are available in the TO-85 14 lead flat package and TO-116 dual in-line plastic package. Suffix "F" to the basic type number; to order plastic package, add Suffix "P".

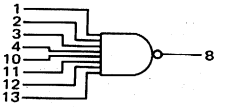




MC3015



This device is an 8-input NAND gate. It is useful when processing a large number of variables, such as in encoders and decoders.



Positive Logic:

$$8 = \overline{1 \cdot 2 \cdot 3 \cdot 4 \cdot 10 \cdot 11 \cdot 12 \cdot 13}$$

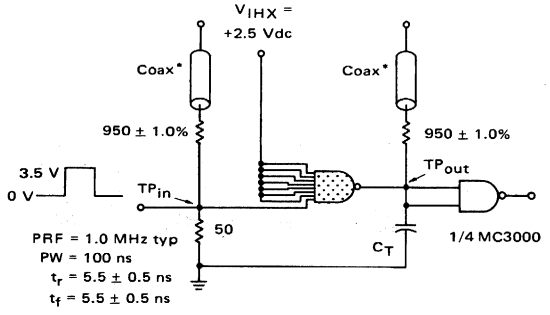
Negative Logic:

$$8 = \overline{1 + 2 + 3 + 4 + 10 + 11 + 12 + 13}$$

Input Loading Factor = 1
Output Loading Factor = 10

Total Power Dissipation = 22 mW typ/pkg
Propagation Delay Time = 8.0 ns typ

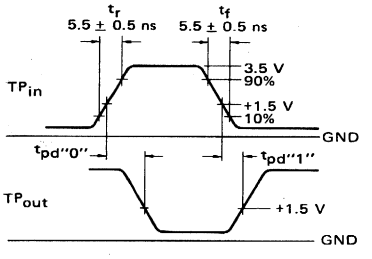
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

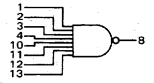
C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one input of this device. To complete testing, sequence through remaining inputs in the same manner.

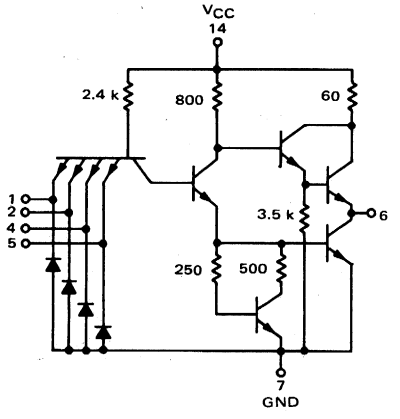


@Test Temperature	TEST CURRENT/VOLTAGE VALUES														
	mA					Volts									
	I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}
0°C	19	23	-2.0	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	-
+25°C	19	23	-2.0	1.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	2.5
+75°C	19	23	-2.0	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	-

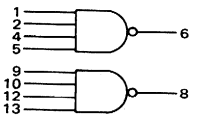
Characteristic	Symbol	Pin Under Test	MC3015 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	Gnd
Input Forward Current	I_{F1}	1	-	-1.9	-	-1.9	-	-1.9	mAdc	-	-	-	-	-	-	-	1	-	2, 3, 4, 10, 11, 12, 13	-	-	14	-	-	7
	I_{F2}	1	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	-	-	-	1	-	2, 3, 4, 10, 11, 12, 13	-	-	-	14	-	7
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	1	-	-	-	-	14	-	2, 3, 4, 7, 10, 11, 12, 13
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	-	-	1	-	-	-	-	-	-	-	-	-	14	-	2, 3, 4, 7, 10, 11, 12, 13
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	-	-	1	-	-	-	-	-	-	-	14	-	-	7
Output Output Voltage	V_{OL1}	8	-	0.4	-	0.4	-	0.4	Vdc	8	-	-	-	-	-	1	-	-	2, 3, 4, 10 11, 12, 13	-	-	14	-	-	7
	V_{OL2}	8	-	0.4	-	0.4	-	0.4	Vdc	-	8	-	-	-	-	1	-	-	2, 3, 4, 10 11, 12, 13	-	-	-	14	-	7
	V_{OH}	8	2.5	-	2.5	-	2.5	-	Vdc	-	-	8	-	-	1	-	-	-	2, 3, 4, 10, 11, 12, 13	-	-	14	-	-	7
Short-Circuit Current	I_{SC}	8	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 3, 4, 7,8, 10, 11, 12,13
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	6.5	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	1, 2, 3, 4, 7, 10, 11, 12, 13
Power Supply Drain	I_{PDH}	14	-	9.0	-	9.0	-	9.0	mAdc	-	-	-	-	-	-	-	-	-	1, 2, 3, 4, 10, 11, 12, 13	-	14	-	-	-	7
	I_{PDL}	14	-	4.3	-	4.3	-	4.3	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 3, 4, 7, 10, 11, 12, 13
Switching Parameters Turn-On Delay	$t_{pd"0"}$	1, 8	-	-	-	12	-	-	ns	Pulse In: 1	Pulse Out: 8	-	-	-	-	-	-	-	-	-	14	-	-	2, 3, 4, 10, 11, 12, 13,	7
Turn-Off Delay	$t_{pd"1"}$	1, 8	-	-	-	12	-	-	ns	1	8	-	-	-	-	-	-	-	-	-	14	-	-	2, 3, 4, 10, 11, 12, 13	7

MC3010

1/2 OF CIRCUIT SHOWN



This device consists of two 4-input NAND gates. These gates may be cross-coupled to form a set-reset flip-flop.

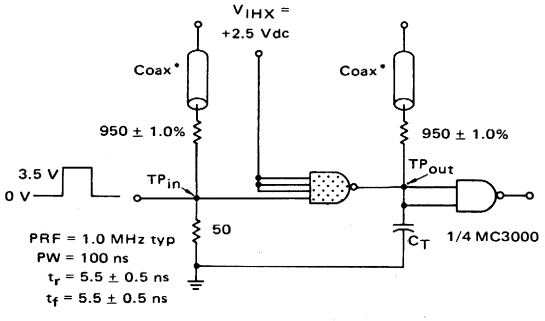


Positive Logic: $6 = \overline{1 \cdot 2 \cdot 4 \cdot 5}$
Negative Logic: $6 = \overline{1 + 2 + 4 + 5}$

Input Loading Factor = 1
Output Loading Factor = 10

Total Power Dissipation = 44 mW typ/pkg
Propagation Delay Time = 6.0 ns typ

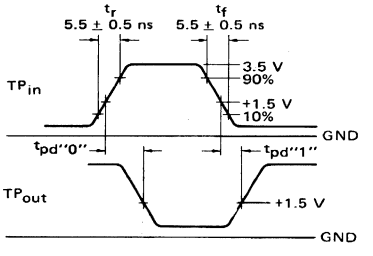
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

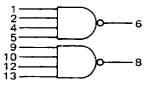
C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gates are tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.



@Test Temperature	I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}
	mA					Volts									
0°C	19	23	-2.0	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	-
+25°C	19	23	-2.0	1.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	2.5
+75°C	19	23	-2.0	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	-

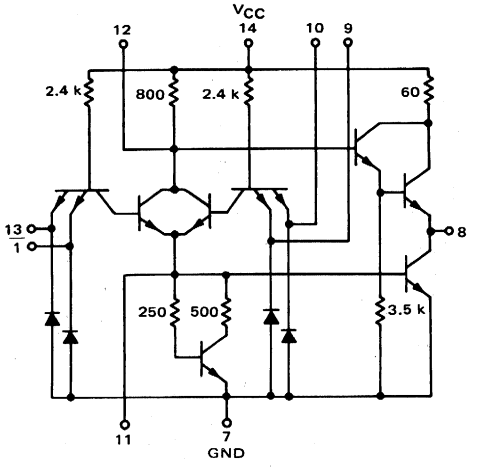
Characteristic	Symbol	Pin Under Test	MC3010 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	Gnd
Input																									
Forward Current	I_{F1}	1	-	-1.9	-	-1.9	-	-1.9	mAdc	-	-	-	-	-	-	-	1	-	2, 4, 5	-	-	14	-	-	7*
	I_{F2}	1	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	-	-	-	1	-	2, 4, 5	-	-	-	14	-	7*
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	1	-	-	-	-	14	-	2, 4, 5, 7*
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	-	-	1	-	-	-	-	-	-	-	-	-	14	-	2, 4, 5, 7*
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	-	-	1	-	-	-	-	-	-	-	14	-	-	7
Output																									
Output Voltage	V_{OL1}	6	-	0.4	-	0.4	-	0.4	Vdc	6	-	-	-	-	-	1	-	-	2, 4, 5	-	-	14	-	-	7*
	V_{OL2}	6	-	0.4	-	0.4	-	0.4	Vdc	-	6	-	-	-	-	1	-	-	2, 4, 5	-	-	-	14	-	7*
	V_{OH}	6	2.5	-	2.5	-	2.5	-	Vdc	-	-	6	-	-	1	-	-	-	2, 4, 5	-	-	14	-	-	7*
Short-Circuit Current	I_{SC}	6	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 4, 5, 6, 7*
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	12.5	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	1, 2, 4, 5, 7, 9, 10, 12, 13
Power Supply Drain	I_{PDH}	14	-	18	-	18	-	18	mAdc	-	-	-	-	-	-	-	-	-	1, 2, 4, 5, 9, 10, 12, 13	-	14	-	-	-	7
	I_{PDL}	14	-	9.0	-	9.0	-	9.0	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 4, 5, 7, 9, 10, 12, 13
Switching Parameters										Pulse In	Pulse Out														
Turn-On Delay	$t_{pd"0}$	1, 6	-	-	-	10	-	-	ns	1	6	-	-	-	-	-	-	-	-	-	14	-	-	2, 4, 5	7*
Turn-Off Delay	$t_{pd"1"}$	1, 6	-	-	-	10	-	-	ns	1	6	-	-	-	-	-	-	-	-	-	14	-	-	2, 4, 5	7*

*Since this is an inverting gate, power drain is minimized by grounding the inputs to gates not under test.

EXPANDABLE DUAL 2-WIDE 2-INPUT "AND-OR-INVERT" GATE

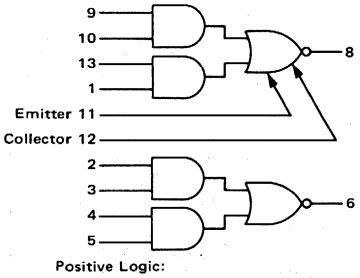
MC3020

1/2 OF CIRCUIT SHOWN †



†Other half of circuit omits expander inputs.

One side of this dual device consists of two 2-input AND gates ORed together and driving an output inverter. The other side consists of two 2-input gates ORed together, driving an output inverter, and the ORing nodes are available for expansion. Up to four AND gates can be ORed together using the MC3030 expander. Care should be taken to minimize the amount of capacitance on the expander terminals in order to maintain switching speeds.



Positive Logic:

$$8 = \overline{(9 \cdot 10) + (13 \cdot 1) + (\text{Expanders})}$$

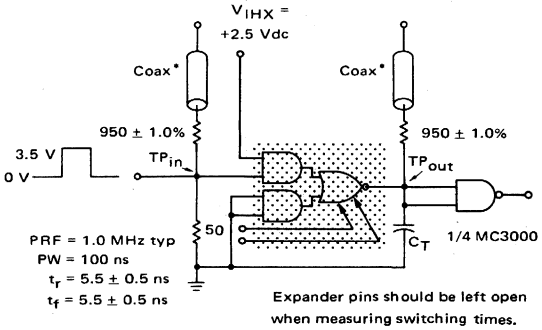
Negative Logic:

$$8 = \overline{(9 + 10) \cdot (13 + 1) \cdot (\text{Expanders})}$$

Input Loading Factor = 1
Output Loading Factor = 10

Total Power Dissipation = 62.5 mW typ/pkg
Propagation Delay Time = 6.0 ns typ

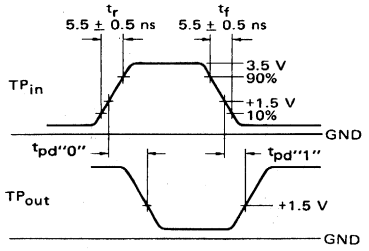
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gate is tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.

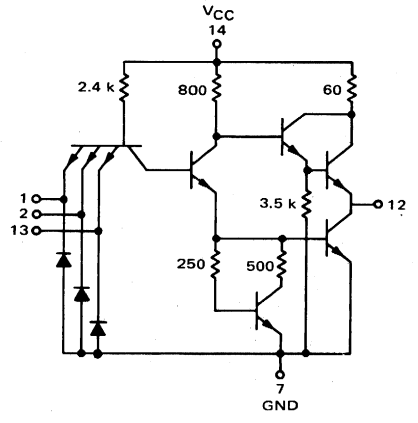
@Test Temperature	TEST CURRENT/VOLTAGE VALUES																
	mA							Volts									
	I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	I_E	I_{EXE}	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}
0°C	19	23	-2.0	-	-	0.3	0.50	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	-
+25°C	19	23	-2.0	1.0	-10	0.3	0.55	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	2.5
+75°C	19	23	-2.0	-	-	0.3	0.70	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	-

Characteristic	Symbol	Pin Under Test	MC3020 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	I_E	I_{EXE}	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	Gnd
Input																											
Forward Current	I_{F1}	1	-	-1.9	-	-1.9	-	-1.9	mAdc	-	-	-	-	-	-	-	-	-	1	-	13	-	-	14	-	-	7, 9, 10 *
	I_{F2}	1	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	-	-	-	-	-	1	-	13	-	-	-	14	-	7, 9, 10*
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	14	-	7, 9, 10, 13*
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	14	-	7, 9, 10, 13 *
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	-	-	1	-	-	-	-	-	-	-	-	-	14	-	-	7, 9, 10 *
Output																											
Output Voltage	V_{OL1}	8	-	0.4	-	0.4	-	0.4	Vdc	8	-	-	-	-	-	-	-	1	-	-	13	-	-	14	-	-	7, 9, 10 *
	V_{OL1}	8	-	0.4	-	0.4	-	0.4	Vdc	8	-	-	-	-	-	11, 12	-	-	-	-	-	-	-	14	-	-	1,7,9,10,13
	V_{OL2}	8	-	0.4	-	0.4	-	0.4	Vdc	-	8	-	-	-	-	11, 12	-	-	-	-	-	-	-	-	14	-	1,7,9,10,13*
	V_{OL2}	8	-	0.4	-	0.4	-	0.4	Vdc	-	8	-	-	-	-	-	-	1	-	-	13	-	-	-	14	-	7, 9, 10*
	V_{OH}	8	2.5	-	2.5	-	2.5	-	Vdc	-	-	8	-	-	-	-	1	-	-	-	13	-	-	14	-	-	1, 7, 10 *
Short-Circuit Current	I_{SC}	8	-	-	-30	-100	-	-	Vdc	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 7, 8, 9, 10, 13 *
Base-Emitter Voltage	$V_{BE\ max}$	11	-	1.010	-	0.975	-	0.935	Vdc	8	-	-	-	-	-	11, 12	-	-	-	-	-	-	-	14	-	-	1, 9, 10, 13 *
	$V_{BE\ min}$	11	0.70	-	0.65	-	0.55	-	Vdc	-	-	-	-	-	11	-	-	-	-	-	-	-	-	14	-	-	1, 9, 10, 12,13 *
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	24	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	1,2,3,4,5,7, 9,10, 13
Power Supply Drain	I_{PDH}	14	-	22	-	22	-	22	mAdc	-	-	-	-	-	-	-	-	-	-	-	1, 2, 3, 4, 5, 9, 10, 13	-	14	-	-	-	7
	I_{PDL}	14	-	14	-	14	-	14	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1,2,3,4,5,7, 9,10,13
Switching Parameters										Pulse In	Pulse Out																
Turn-On Delay	$t_{pd"0"}$	1, 8	-	-	-	12	-	-	ns	1	8	-	-	-	-	-	-	-	-	-	-	-	14	-	-	13	7, 9, 10 *
Turn-Off Delay	$t_{pd"1"}$	1, 8	-	-	-	12	-	-	ns	1	8	-	-	-	-	-	-	-	-	-	-	-	14	-	-	13	7, 9, 10 *

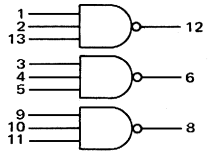
*Since this is an inverting gate, power drain is minimized by grounding the inputs to gates not under test.

MC3005

1/3 OF CIRCUIT SHOWN



This package consists of three 3-input NAND gates. Each gate may be used as an inverter, or two gates may be cross-coupled to form bistable circuits.



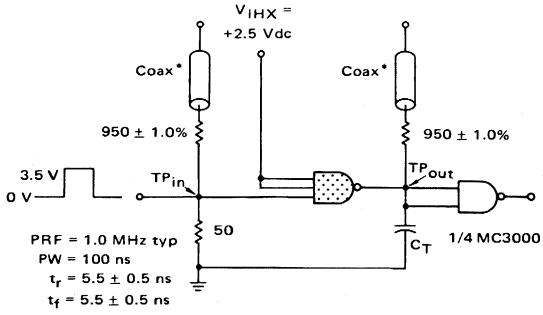
Positive Logic: $12 = \overline{1 \cdot 2 \cdot 13}$

Negative Logic: $12 = \overline{1 + 2 + 13}$

Input Loading Factor = 1
Output Loading Factor = 10

Total Power Dissipation = 66 mW typ/pkg
Propagation Delay Time = 6.0 ns typ

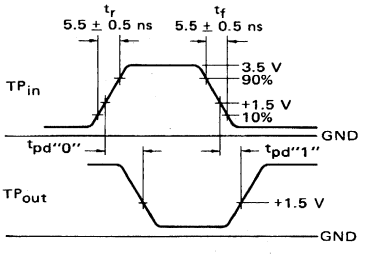
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

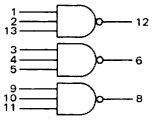
C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gates are tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.



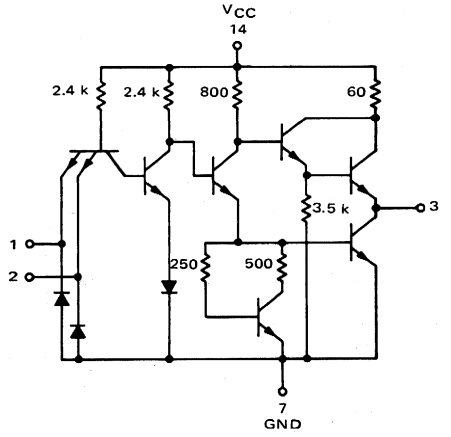
@Test Temperature	TEST CURRENT/VOLTAGE VALUES														
	mA					Volts									
	I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}
0°C	19	23	-2.0	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	-
+25°C	19	23	-2.0	1.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	2.5
+75°C	19	23	-2.0	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	-

Characteristic	Symbol	Pin Under Test	MC3005 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	Gnd
Input																									
Forward Current	I_{F1}	1	-	-1.9	-	-1.9	-	-1.9	mAdc	-	-	-	-	-	-	-	1	-	2, 13	-	-	14	-	-	7*
	I_{F2}	1	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	-	-	-	1	-	2, 13	-	-	-	14	-	7*
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	1	-	-	-	-	14	-	2, 7, 13*
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	-	-	1	-	-	-	-	-	-	-	-	-	14	-	2, 7, 13*
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	-	-	1	-	-	-	-	-	-	-	14	-	-	7*
Output																									
Output Voltage	V_{OL1}	12	-	0.4	-	0.4	-	0.4	Vdc	12	-	-	-	-	-	1	-	-	2, 13	-	-	14	-	-	7*
	V_{OL2}	12	-	0.4	-	0.4	-	0.4	Vdc	-	12	-	-	-	-	1	-	-	2, 13	-	-	-	14	-	7*
	V_{OH}	12	2.5	-	2.5	-	2.5	-	Vdc	-	-	12	-	-	1	-	-	-	2, 13	-	-	14	-	-	7*
Short-Circuit Current	I_{SC}	12	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 7,* 12, 13
Power Requirements (Total Device)																									
Maximum Power Supply Current	I_{max}	14	-	-	-	20	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	1,2,3,4,5,7, 9, 10, 11, 13
Power Supply Drain	I_{PDH}	14	-	27	-	27	-	27	mAdc	-	-	-	-	-	-	-	-	-	1, 2, 3, 4, 5, 9, 10, 11, 13	-	14	-	-	-	7
	I_{PDL}	14	-	12.5	-	12.5	-	12.5	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1,2,3,4,5,7, 9,10,11,13
Switching Parameters										Pulse In	Pulse Out														
Turn-On Delay	$t_{pd"0"}$	1, 12	-	-	-	10	-	-	ns	1	12	-	-	-	-	-	-	-	-	-	14	-	-	2, 13	7*
Turn-Off Delay	$t_{pd"1"}$	1, 12	-	-	-	10	-	-	ns	1	12	-	-	-	-	-	-	-	-	-	14	-	-	2, 13	7*

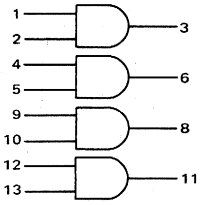
*Since this is an inverting gate, power drain is minimized by grounding the inputs to gates not under test.

MC3001

1/4 OF CIRCUIT SHOWN



This device consists of four 2-input AND gates. This non-inverting function is useful for optimizing logic design, or for direct implementation of standard logic equations.

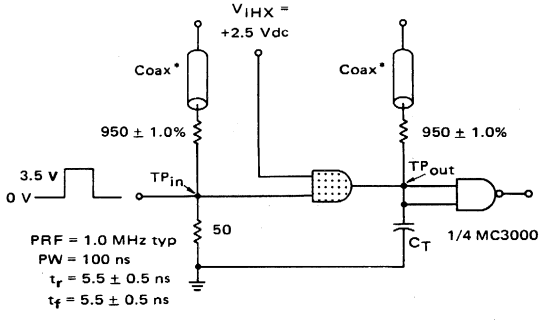


Positive Logic: 3 = 1 · 2
Negative Logic: 3 = 1 + 2

Input Loading Factor = 1
Output Loading Factor = 10

Total Power Dissipation = 112 mW typ/pkg
Propagation Delay Time = 9.0 ns typ

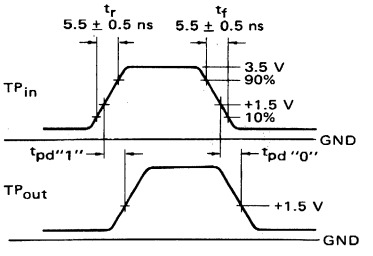
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

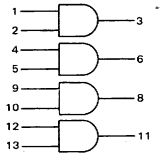
C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gates are tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.



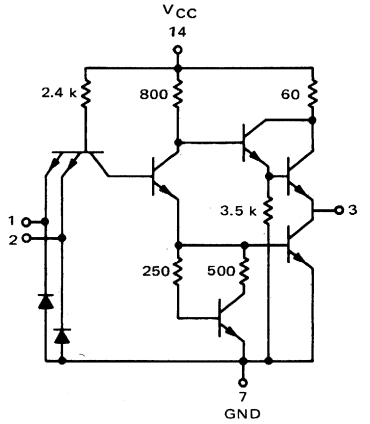
@Test Temperature	TEST CURRENT/VOLTAGE VALUES														
	mA					Volts									
	I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}
0°C	19	23	-2.0	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	-
+25°C	19	23	-2.0	1.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	2.5
+75°C	19	23	-2.0	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	-

Characteristic	Symbol	Pin Under Test	MC3001 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	Gnd
Input																									
Forward Current	I_{F1}	1	-	-1.9	-	-1.9	-	-1.9	mAdc	-	-	-	-	-	-	-	1	-	2*	-	-	14	-	-	7
	I_{F2}	1	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	-	-	-	1	-	2*	-	-	-	14	-	7
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	1	*	-	-	-	14	-	2,7
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	-	-	1	-	-	-	-	-	*	-	-	-	14	-	2,7
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	-	-	1	-	-	-	-	*	-	-	14	-	-	7
Output																									
Output Voltage	V_{OL1}	3	-	0.4	-	0.4	-	0.4	Vdc	3	-	-	-	-	1	-	-	-	2*	-	-	14	-	-	7
	V_{OL2}	3	-	0.4	-	0.4	-	0.4	Vdc	-	3	-	-	-	1	-	-	-	2*	-	-	-	14	-	7
	V_{OH}	3	2.5	-	2.5	-	2.5	-	Vdc	-	-	3	-	-	-	1	-	-	2*	-	-	14	-	-	7
Short-Circuit Current	I_{SC}	3	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	1, 2*	-	14	-	-	-	3,7
Power Requirements (Total Device)																									
Maximum Power Supply Current	I_{max}	14	-	-	-	34	-	-	mAdc	-	-	-	-	-	-	-	-	-	1,2,4,5,9, 10,12,13	14	-	-	-	-	7
Power Supply Drain	I_{PDH}	14	-	24	-	24	-	24	mAdc	-	-	-	-	-	-	-	-	-	1,2,4,5,9, 10,12,13	-	14	-	-	-	7
	I_{PDL}	14	-	48	-	48	-	48	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1,2,4,5,7, 9,10,12,13
Switching Parameters										Pulse In	Pulse Out														
Turn-On Delay	$t_{pd"0"}$	1, 3	-	-	-	12	-	-	ns	1	3	-	-	-	-	-	-	-	*	-	14	-	-	2	7
Turn-Off Delay	$t_{pd"1"}$	1, 3	-	-	-	12	-	-	ns	1	3	-	-	-	-	-	-	-	*	-	14	-	-	2	7

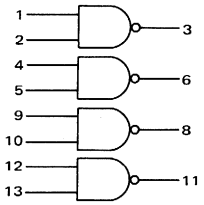
*Since this is a non-inverting gate, power drain is minimized by tying the inputs to gates not under test to V_{RH}.

MC3000

1/4 OF CIRCUIT SHOWN



This device consists of four 2-input NAND gates. Each gate may be used as an inverter, or two gates may be cross-coupled to form bistable circuits.



Positive Logic: $3 = \overline{1 \cdot 2}$

Negative Logic: $3 = \overline{1 + 2}$

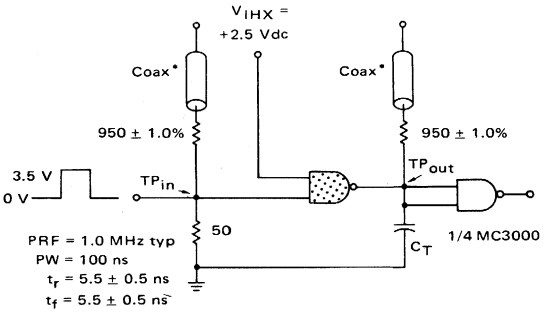
Input Loading Factor = 1

Output Loading Factor = 10

Total Power Dissipation = 88 mW typ/pkg

Propagation Delay Time = 6.0 ns typ

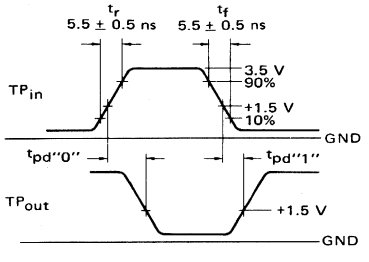
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

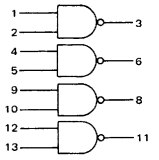
C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gates are tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.



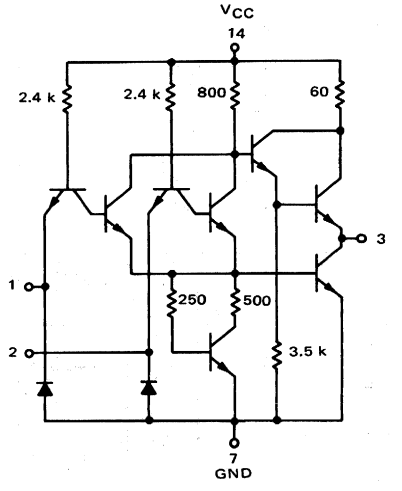
@Test Temperature	TEST CURRENT / VOLTAGE VALUES														
	mA					Volts									
	I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}
0°C	19	23	-2.0	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	-
+25°C	19	23	-2.0	1.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	2.5
+75°C	19	23	-2.0	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	-

Characteristic	Symbol	Pin Under Test	MC3000 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	Gnd
Input																									
Forward Current	I_{F1}	1	-	-1.9	-	-1.9	-	-1.9	mAdc	-	-	-	-	-	-	-	1	-	2	-	-	14	-	-	7*
	I_{F2}	1	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	-	-	-	1	-	2	-	-	-	14	-	7*
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	1	-	-	-	-	14	-	2,7*
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	-	-	1	-	-	-	-	-	-	-	-	-	-	14	-	2,7*
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	-	-	1	-	-	-	-	-	-	-	-	14	-	-	7*
Output																									
Output Voltage	V_{OL1}	3	-	0.4	-	0.4	-	0.4	Vdc	3	-	-	-	-	-	1	-	-	2	-	-	14	-	-	7*
	V_{OL2}	3	-	0.4	-	0.4	-	0.4	Vdc	-	3	-	-	-	-	1	-	-	2	-	-	-	14	-	7*
	V_{OH}	3	2.5	-	2.5	-	2.5	-	Vdc	-	-	3	-	-	1	-	-	-	2	-	-	14	-	-	7*
Short-Circuit Current	I_{SC}	3	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 3, 7*
Power Requirements (Total Device)																									
Maximum Power Supply Current	I_{max}	14	-	-	-	25	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	1, 2, 4, 5, 7, 9, 10, 12, 13
Power Supply Drain	I_{PDH}	14	-	36	-	36	-	36	mAdc	-	-	-	-	-	-	-	-	-	1, 2, 4, 5, 9, 10, 12, 13	-	14	-	-	-	7
	I_{PDL}	14	-	17.5	-	17.5	-	17.5	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 4, 5, 7, 9, 10, 12, 13
Switching Parameters										Pulse In	Pulse Out														
Turn-On Delay	$t_{pd"0"}$	1, 3	-	-	-	10	-	-	ns	1	3	-	-	-	-	-	-	-	-	-	14	-	-	2	7*
Turn-Off Delay	$t_{pd"1"}$	1,3	-	-	-	10	-	-	ns	1	3	-	-	-	-	-	-	-	-	-	14	-	-	2	7*

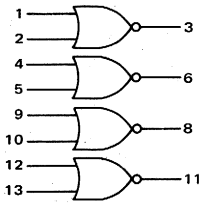
*Since this is an inverting gate, power drain is minimized by grounding the inputs to gates not under test.

MC3002

1/4 OF CIRCUIT SHOWN



This device consists of four 2-input NOR gates. Each gate may be used as an inverter, or two gates may be cross-coupled to form bistable circuits.



Positive Logic: $3 = \overline{1+2}$

Negative Logic: $3 = \overline{1 \bullet 2}$

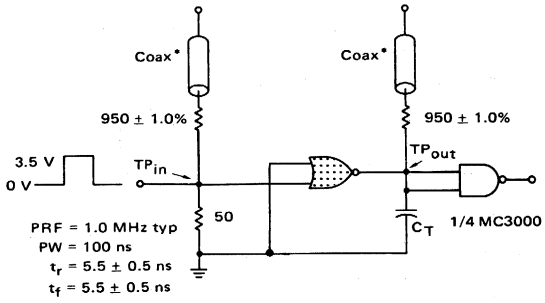
Input Loading Factor = 1

Output Loading Factor = 10

Total Power Dissipation = 122 mW typ/pkg

Propagation Delay Time = 6.0 ns typ

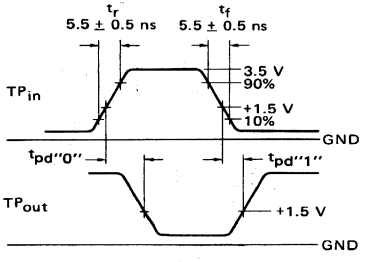
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

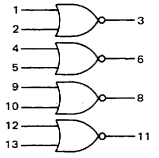
C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gates are tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.



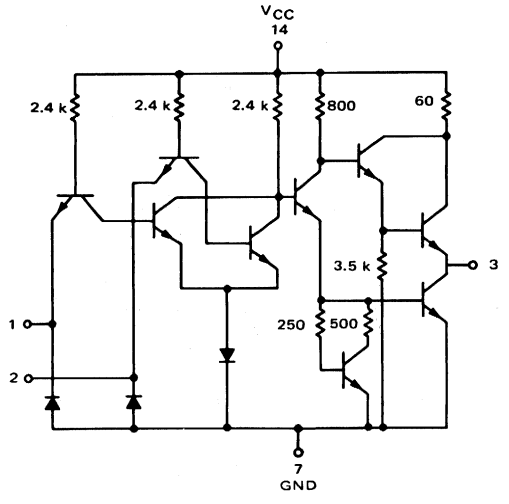
@Test Temperature	I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}
	mA					Volts								
0°C	19	23	-2.0	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5
+25°C	19	23	-2.0	1.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5
+75°C	19	23	-2.0	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5

Characteristic	Symbol	Pin Under Test	MC3002 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	Gnd
Input																								
Forward Current	I_{F1}	1	-	-1.9	-	-1.9	-	-1.9	mAdc	-	-	-	-	-	-	-	1	-	2	-	-	14	-	7*
	I_{F2}	1	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	-	-	-	1	-	2	-	-	-	14	7*
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	1	-	-	-	-	14	2, 7*
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	-	-	1	-	-	-	-	-	-	-	-	-	14	2, 7*
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	-	-	1	-	-	-	-	-	-	-	14	-	7*
Output																								
Output Voltage	V_{OL1}	3	-	0.4	-	0.4	-	0.4	Vdc	3	-	-	-	-	-	1	-	-	-	-	-	14	-	2, 7*
	V_{OL2}	3	-	0.4	-	0.4	-	0.4	Vdc	-	3	-	-	-	-	1	-	-	-	-	-	-	14	2, 7*
	V_{OH}	3	2.5	-	2.5	-	2.5	-	Vdc	-	-	3	-	-	1	-	-	-	-	-	-	14	-	2, 7*
Short-Circuit Current	I_{SC}	3	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	1, 2, 3, 7*
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	38	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 4, 5, 7, 9, 10, 12, 13
Power Supply Drain	I_{PDH}	14	-	43	-	43	-	43	mAdc	-	-	-	-	-	-	-	-	-	1, 2, 4, 5, 9, 10, 12, 13	-	14	-	-	7
	I_{PDL}	14	-	27	-	27	-	27	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	1, 2, 4, 5, 7, 9, 10, 12, 13
Switching Parameters										Pulse In	Pulse Out													
Turn-On Delay	$t_{pd"0"}$	1, 3	-	-	-	10	-	-	ns	1	3	-	-	-	-	-	-	-	-	-	14	-	-	2, 7*
Turn-Off Delay	$t_{pd"1"}$	1, 3	-	-	-	10	-	-	ns	1	3	-	-	-	-	-	-	-	-	-	14	-	-	2, 7*

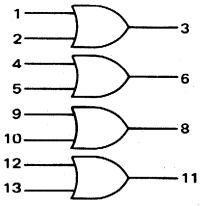
*Since this is an inverting gate, power drain is minimized by grounding the inputs to gates not under test.

MC3003

1/4 OF CIRCUIT SHOWN



This device consists of four 2-input OR gates. This non-inverting function is useful for optimizing logic design, or for direct implementation of standard logic equations.

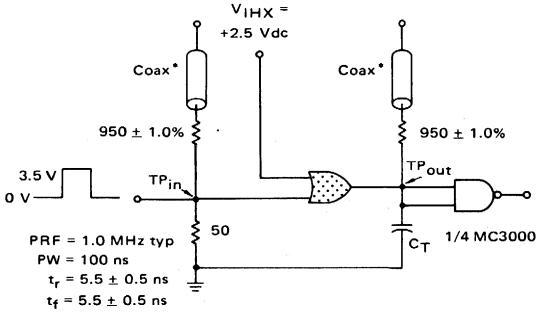


Positive Logic: 3 = 1 + 2
Negative Logic: 3 = 1 · 2

Input Loading Factor = 1
Output Loading Factor = 10

Total Power Dissipation = 150 mW typ/pkg
Propagation Delay Time = 9.0 ns typ

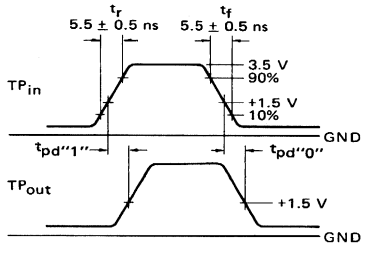
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

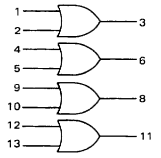
C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gates are tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.



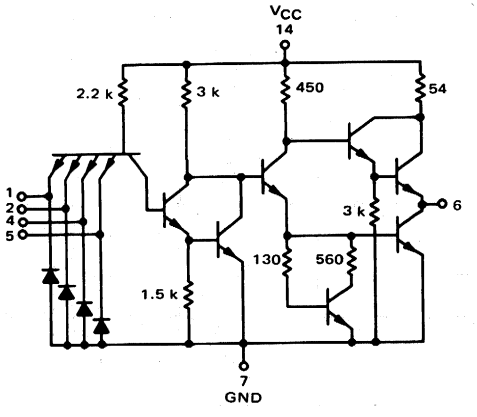
@Test Temperature	I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}
	TEST CURRENT/VOLTAGE VALUES														
	mA					Volts									
0°C	19	23	-2.0	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	-
+25°C	19	23	-2.0	1.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	2.5
+75°C	19	23	-2.0	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	-

Characteristic	Symbol	Pin Under Test	MC3003 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	Gnd
										TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW:															
Input																									
Forward Current	I_{F1}	1	-	-1.9	-	-1.9	-	-1.9	mAdc	-	-	-	-	-	-	-	1	-	2*	-	-	14	-	-	7
	I_{F2}	1	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	-	-	-	1	-	2*	-	-	-	14	-	7
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	1	*	-	-	-	14	-	2,7
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	-	-	1	-	-	-	-	-	*	-	-	-	14	-	2,7
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	-	-	1	-	-	-	-	*	-	-	14	-	-	7
Output																									
Output Voltage	V_{OL1}	3	-	0.4	-	0.4	-	0.4	Vdc	3	-	-	-	-	1	-	-	-	2*	-	-	14	-	-	7
	V_{OL2}	3	-	0.4	-	0.4	-	0.4	Vdc	-	3	-	-	-	1	-	-	-	2*	-	-	-	14	-	7
	V_{OH}	3	2.5	-	2.5	-	2.5	-	Vdc	-	-	3	-	-	-	1	-	-	2*	-	-	14	-	-	7
Short-Circuit Current	I_{SC}	3	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	1, 2*	-	14	-	-	-	3,7
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	45	-	-	mAdc	-	-	-	-	-	-	-	-	-	1,2,4,5,9, 10,12,13	14	-	-	-	-	7
Power Supply Drain	I_{PDH}	14	-	32	-	32	-	32	mAdc	-	-	-	-	-	-	-	-	-	1,2,4,5,9, 10,12,13	-	14	-	-	-	7
	I_{PDL}	14	-	55	-	55	-	55	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1,2,4,5,7, 9,10,12,13
										Pulse In	Pulse Out														
Switching Parameters Turn-On Delay	$t_{pd"0"}$	1, 3	-	-	-	12	-	-	ns	1	3	-	-	-	-	-	-	-	*	-	14	-	-	2	7
Turn-Off Delay	$t_{pd"1"}$	1, 3	-	-	-	12	-	-	ns	1	3	-	-	-	-	-	-	-	*	-	14	-	-	2	7

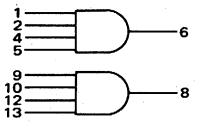
*Since this is a non-inverting gate, power drain is minimized by tying the inputs to gates not under test to V_{RH}

MC3026

1/2 OF CIRCUIT SHOWN



This device consists of two 4-input AND power gates. Each gate is designed for driving high fan-out loads (20).

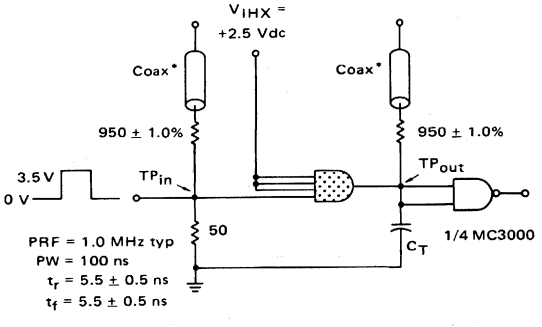


Positive Logic: $6 = 1 \cdot 2 \cdot 4 \cdot 5$
Negative Logic: $6 = 1 + 2 + 4 + 5$

Input Loading Factor = 1.1
Output Loading Factor = 20

Total Power Dissipation = 90 mW typ/pkg
Propagation Delay Time = 9.0 ns typ

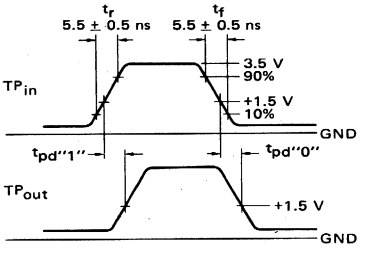
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

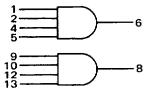
C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gate is tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.

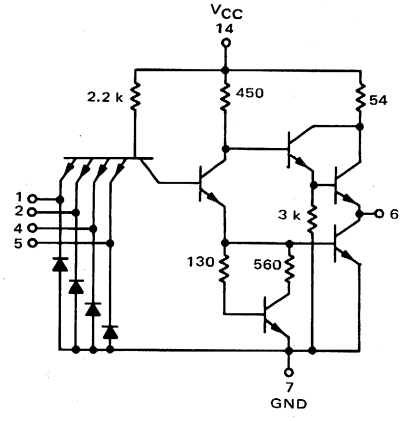


Characteristic	Symbol	Pin Under Test	MC3026 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	@Test Temperature	TEST CURRENT/VOLTAGE VALUES mA I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	Volts V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	Gnd
										0°C	38	46	-4.0	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	-	
										+25°C	38	46	-4.0	1.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	2.5	
										+75°C	38	46	-4.0	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	-	
											TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW:															
Input																										
Forward Current	I_{F1}	1	-	-2.1	-	-2.1	-	-2.1	mAdc		-	-	-	-	-	-	-	1	-	2, 4, 5 *	-	-	14	-	-	7
	I_{F2}	1	-	-2.6	-	-2.6	-	-2.6	mAdc		-	-	-	-	-	-	-	1	-	2, 4, 5 *	-	-	-	14	-	7
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc		-	-	-	-	-	-	-	-	1	*	-	-	-	14	-	2, 4, 5, 7
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc		-	-	-	1	-	-	-	-	-	*	-	-	-	14	-	2, 4, 5, 7
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc		-	-	-	-	I	-	-	-	-	*	-	-	14	-	-	7
Output																										
Output Voltage	V_{OL1}	6	-	0.4	-	0.4	-	0.4	Vdc		6	-	-	-	-	1	-	-	-	2, 4, 5 *	-	-	14	-	-	7
	V_{OL2}	6	-	0.4	-	0.4	-	0.4	Vdc		-	6	-	-	-	1	-	-	-	2, 4, 5 *	-	-	-	14	-	7
	V_{OH}	6	2.5	-	2.5	-	2.5	-	Vdc		-	-	6	-	-	-	1	-	-	2, 4, 5 *	-	-	14	-	-	7
Short-Circuit Current	I_{SC}	6	-	-	-50	-125	-	-	mAdc		-	-	-	-	-	-	-	-	-	1, 2, 4, 5 *	-	14	-	-	-	6, 7
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	22	-	-	mAdc		-	-	-	-	-	-	-	-	-	1, 2, 4, 5, 9, 10, 12, 13	14	-	-	-	-	7
Power Supply Drain	I_{PDH}	14	-	14	-	14	-	14	mAdc		-	-	-	-	-	-	-	-	-	1, 2, 4, 5, 9, 10, 12, 13	-	14	-	-	-	7
	I_{PDL}	14	-	38	-	38	-	38	mAdc		-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 4, 5, 7, 9, 10, 12, 13
Switching Parameters											Pulse In	Pulse Out														
Turn-On Delay	$t_{pd"0"}$	1, 6	-	-	-	15	-	-	ns		1	6	-	-	-	-	-	-	-	*	-	14	-	-	2, 4, 5	7
Turn-Off Delay	$t_{pd"1"}$	1, 6	-	-	-	15	-	-	ns		1	6	-	-	-	-	-	-	-	*	-	14	-	-	2, 4, 5	7

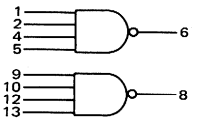
*Since this is a non-inverting gate, power drain is minimized by tying the inputs to gates not under test to V_{RH}.

MC3025

1/2 OF CIRCUIT SHOWN



This device consists of two 4-input NAND power gate circuits. Each gate is designed for driving high fan-out loads (20).



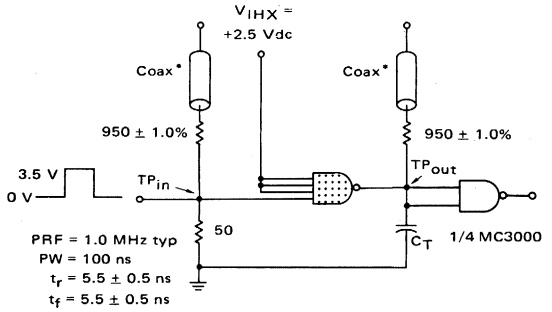
Positive Logic: $6 = \overline{1 \cdot 2 \cdot 4 \cdot 5}$

Negative Logic: $6 = \overline{1 + 2 + 4 + 5}$

Input Loading Factor = 1.1
Output Loading Factor = 20

Total Power Dissipation = 70 mW typ/pkg
Propagation Delay Time = 6.0 ns typ

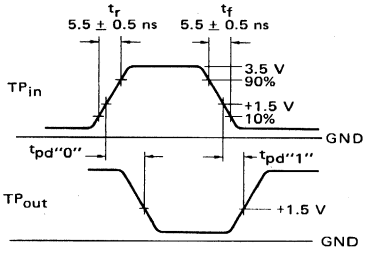
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

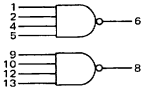
C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one gate. The other gate is tested in the same manner. Further, test procedures are shown for only one input of the gate under test. To complete testing, sequence through remaining inputs.



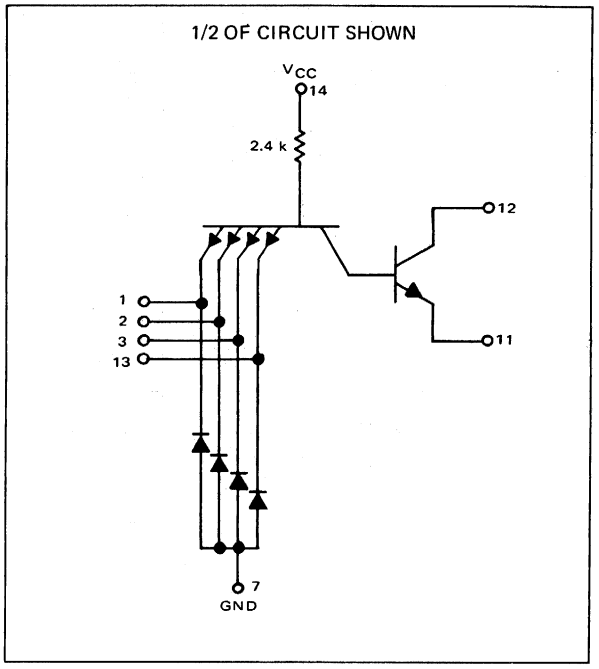
@Test Temperature	TEST CURRENT/VOLTAGE VALUES														
	mA					Volts									
	I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}
0°C	38	46	-4.0	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	-
+25°C	38	46	-4.0	1.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	2.5
+75°C	38	46	-4.0	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	-

Characteristic	Symbol	Pin Under Test	MC3025 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL1}	I_{OL2}	I_{OH}	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	Gnd
Input Forward Current	I_{F1}	1	-	-2.1	-	-2.1	-	-2.1	mAdc	-	-	-	-	-	-	-	1	-	2, 4, 5	-	-	14	-	-	7*
	I_{F2}	1	-	-2.6	-	-2.6	-	-2.6	mAdc	-	-	-	-	-	-	-	1	-	2, 4, 5	-	-	-	14	-	7*
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	1	-	-	-	-	14	-	2, 4, 5, 7*
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	-	-	1	-	-	-	-	-	-	-	-	-	14	-	2, 4, 5, 7*
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	-	-	1	-	-	-	-	-	-	-	14	-	-	7*
Output Output Voltage	V_{OL1}	6	-	0.4	-	0.4	-	0.4	Vdc	6	-	-	-	-	-	1	-	-	2, 4, 5	-	-	14	-	-	7*
	V_{OL2}	6	-	0.4	-	0.4	-	0.4	Vdc	-	6	-	-	-	-	1	-	-	2, 4, 5	-	-	-	14	-	7*
	V_{OH}	6	2.5	-	2.5	-	2.5	-	Vdc	-	-	6	-	-	1	-	-	-	2, 4, 5	-	-	14	-	-	7
Short-Circuit Current	I_{SC}	6	-	-	-50	-125	-	-	mA	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1,2,4,5,6,7*
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	16	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	1, 2, 4, 5, 7 9,10, 12, 13
Power Supply Drain	I_{PDH}	14	-	32	-	32	-	32	mAdc	-	-	-	-	-	-	-	-	-	1, 2, 4, 5, 9, 10, 12, 13	-	14	-	-	-	7
	I_{PDL}	14	-	10	-	10	-	10	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 4, 5, 7 9,10, 12, 13
Switching Parameters										Pulse In	Pulse Out														
Turn-On Delay	$t_{pd"0"}$	1,6	-	-	-	12	-	-	ns	1	6	-	-	-	-	-	-	-	-	-	14	-	-	2, 4, 5	7*
Turn-Off Delay	$t_{pd"1"}$	1,6	-	-	-	12	-	-	ns	1	6	-	-	-	-	-	-	-	-	-	14	-	-	2, 4, 5	7*

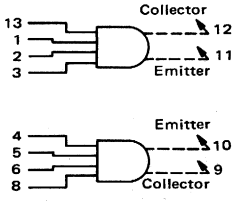
*Since this is an inverting gate, power drain is minimized by grounding the inputs to gates not under test.

DUAL 4-INPUT EXPANDER FOR "AND-OR-INVERT" GATES

MC3030



This device consists of two independent 4-input AND gates. The outputs of each gate are available as ORing nodes. Using the MC3030 expander, with the MC3020 expandable gate, up to four AND gates can be ORed together.



Input Loading Factor = 1
Full output loading factor of the expandable gate is maintained.

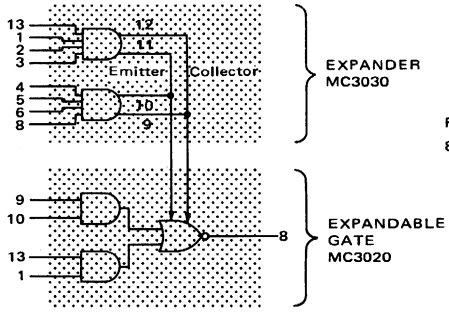
Total Power Dissipation = 15 mW typ/pkg

Propagation Delay Time:

Δt_{pd} = +1.0 ns typ
When added to the expandable "AND-OR-INVERT" gate.

$\Delta t_{pd}/pF$ = +1.0 ns pF typ
Caused by additional capacitance at expansion points.

APPLICATION: EXPANDABLE 2-WIDE 2-INPUT AND-OR-INVERT GATE WITH A DUAL 4-INPUT EXPANDER CONNECTED



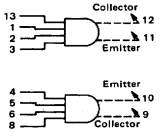
Positive Logic:

$$8 = \overline{(9 \bullet 10) + (13 \bullet 1)} + \overline{(13 \bullet 1 \bullet 2 \bullet 3) + (4 \bullet 5 \bullet 6 \bullet 8)}$$

Expandable Gate — Expander

ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one expander. The other expander is tested in a similar manner. Further, test procedures are shown for only one input of the expander being tested. To complete testing, sequence through remaining inputs.



@Test Temperature	TEST CURRENT/VOLTAGE VALUES (mA) I_C	I_{in}	I_D	V_R	V_{RH}	V_F	V_{EE1}	V_{EE2}	V_{IH}	V_{IL}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}
0°C	6.0	-	-	2.5	4.0	0.4	1.010	0.70	2.0	1.1	-	5.0	4.5	5.5
+25°C	6.0	1.0	-10	2.5	4.0	0.4	0.975	0.65	1.8	1.1	7.0	5.0	4.5	5.5
+75°C	6.0	-	-	2.5	4.0	0.4	0.935	0.55	1.8	0.9	-	5.0	4.5	5.5

Characteristic	Symbol	Pin Under Test	MC3030 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: I_C	I_{in}	I_D	V_R	V_{RH}	V_F	V_{EE1}	V_{EE2}	V_{IH}	V_{IL}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	Gnd
Input																								
Forward Current	I_{F1}	1	-	-1.9	-	-1.9	-	-1.9	mAdc	-	-	-	-	2, 3, 13	1	-		-	-	-	-	14	-	7*
	I_{F2}	1	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	2, 3, 13	1	-	-	-	-	-	-	-	14	7*
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	1	-	-	-	-	-	-	-	-	-	14	2, 3, 7, 13*
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	1	-	-	-	-	-	-	-	-	-	-	-	14	2, 3, 7, 13*
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	1	-	-	-	-	-	-	-	-	-	14	-	7*
Output																								
Output Voltage	V_{OL}	12	-	1.41	-	1.38	-	1.34	Vdc	12	-	-	-	-	-	11	-	1	-	-	-	14	-	7*
Emitter Current	I_{EO}	11	-	-300	-	-300	-	-300	μAdc	-	-	-	-	-	-	-	11	-	1	-	-	12, 14	-	7**
Collector Current	I_{CO}	12	-	300	-	300	-	300	μAdc	-	-	-	-	-	-	-	11	1	-	-	-	12, 14	-	7*
Power Requirements (Total Device)																								
Maximum Power Supply Current	I_{max}	14	-	-	-	7.0	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1,2,3,4,5, 6,7,8,13
Power Supply Drain	I_{PDL}	14	-	5.0	-	5.0	-	5.0	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	1,2,3,4,5, 6,7,8,13

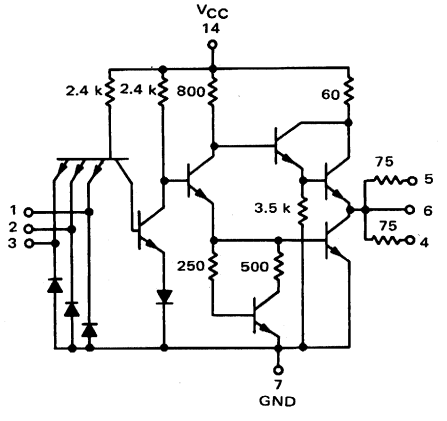
* Ground inputs to gates not under test unless otherwise noted.

** The inputs to both gates are ungrounded.

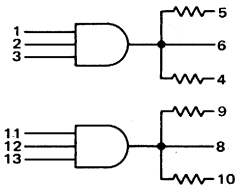
DUAL 3-INPUT 3-OUTPUT "AND" SERIES TERMINATED LINE DRIVER

MC3028

1/2 OF CIRCUIT SHOWN



This device is a dual 3-input/3-output series-terminated AND line driver that minimizes switching transients on long lines by approximating line impedance. Two outputs are provided through 75-ohm resistors for use when driving 93 to 120-ohm lines. These outputs should be paralleled when driving 50 to 93-ohm lines. In addition, an output is provided directly at the gate output node for driving adjacent gates.



Positive Logic: 4, 5, 6, = 1 · 2 · 3

Negative Logic: 4, 5, 6, = 1 + 2 + 3

Input Loading Factor = 1

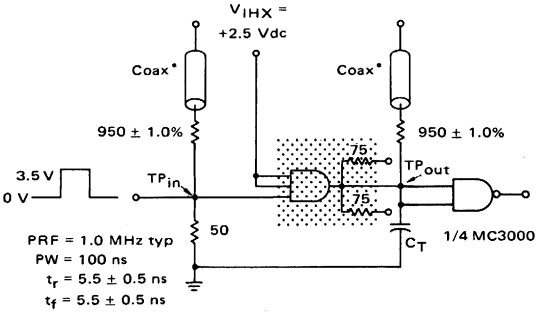
Output Loading Factor, Direct Output (Pins 6 & 8) = 10 minus the number of resistor-terminated outputs being used.

Output Loading Factor, Resistors (Pins 4, 5, 9, & 10) = 1

Total Power Dissipation = 56 mW typ/pkg

Propagation Delay Time = 9.0 ns typ

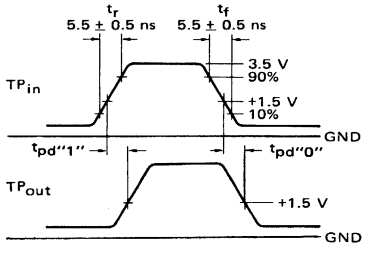
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

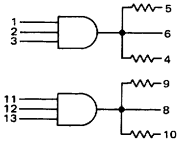
C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one line driver. The other line driver is tested in the same manner. Further, test procedures are shown for only one input of the line driver being tested. To complete testing, sequence through remaining inputs.

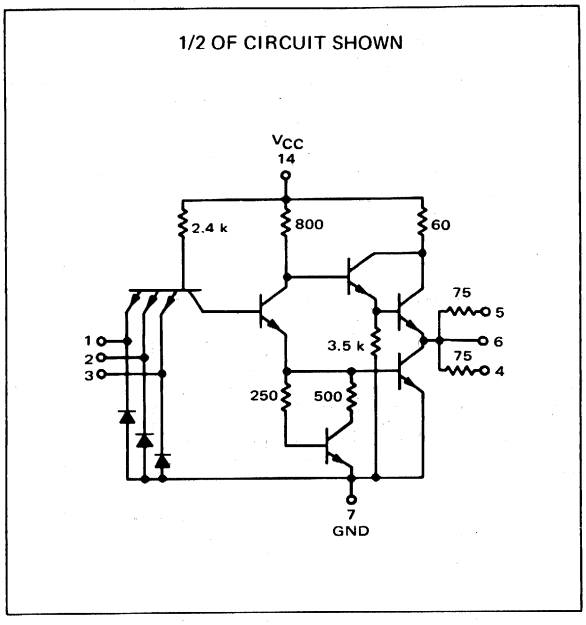


@Test Temperature	TEST CURRENT/VOLTAGE VALUES																							
	mA											Volts												
	$I_{OL\,1A}$	$I_{OL\,1B}$	$I_{OL\,1C}$	$I_{OL\,2A}$	$I_{OL\,2B}$	$I_{OL\,2C}$	$I_{OH\,A}$	$I_{OH\,B}$	$I_{OH\,C}$	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}			
0°C	15.2	1.9	1.9	18.4	2.3	2.3	-1.8	-0.1	-0.1	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	-			
+25°C	15.2	1.9	1.9	18.4	2.3	2.3	-1.8	-0.1	-0.1	1.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	2.5			
+75°C	15.2	1.9	1.9	18.4	2.3	2.3	-1.8	-0.1	-0.1	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	-			

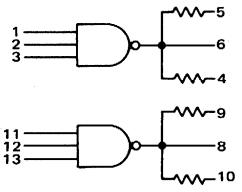
Characteristic	Symbol	Pin Under Test	MC3028 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: $I_{OL\,1A}$	$I_{OL\,1B}$	$I_{OL\,1C}$	$I_{OL\,2A}$	$I_{OL\,2B}$	$I_{OL\,2C}$	$I_{OH\,A}$	$I_{OH\,B}$	$I_{OH\,C}$	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	Gnd
Input Forward Current	I_{F1}	1	-	-1.9	-	-1.9	-	-1.9	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2, 3*	-	-	14	-	-	7
	I_{F2}	1	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2, 3*	-	-	-	14	-	7
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	*	-	-	-	14	-	2, 3, 7
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	*	-	-	-	14	-	2, 3, 7
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	*	-	-	14	-	-	7
Output Output Voltage	$V_{OL\,1}$	6	-	0.4	-	0.4	-	0.4	Vdc	6	5	4	-	-	-	-	-	-	-	-	1	-	-	-	2, 3*	-	-	14	-	-	7
	$V_{OL\,2}$	6	-	0.4	-	0.4	-	0.4	Vdc	-	-	-	6	5	4	-	-	-	-	-	1	-	-	-	2, 3*	-	-	-	14	-	7
	$V_{OL\,3}$	5	-	0.5	-	0.5	-	0.5	Vdc	6	5	4	-	-	-	-	-	-	-	-	1	-	-	-	2, 3*	-	-	14	-	-	7
	$V_{OL\,4}$	5	-	0.5	-	0.5	-	0.5	Vdc	-	-	-	6	5	4	-	-	-	-	-	1	-	-	-	2, 3*	-	-	-	14	-	7
	V_{OH}	6	2.5	-	2.5	-	2.5	-	Vdc	-	-	-	-	-	-	6	5	4	-	-	-	1	-	-	2, 3*	-	-	14	-	-	7
Short-Circuit Current	I_{SC}	6	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1, 2, 3*	-	14	-	-	-	6, 7
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	18	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1, 2, 3, 11, 12, 13	14	-	-	-	-	7
Power Supply Drain	I_{PDH}	14	-	12	-	12	-	12	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1, 2, 3, 11, 12, 13	-	14	-	-	-	7
	I_{PDL}	14	-	24	-	24	-	24	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 3, 7 11, 12, 13
Switching Parameters										Pulse In	Pulse Out																				
Turn-On Delay	$t_{pd"0"}$	1, 6	-	-	-	12	-	-	ns	1	6	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	14	-	-	2, 3	7
Turn-Off Delay	$t_{pd"1"}$	1, 6	-	-	-	12	-	-	ns	1	6	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	14	-	-	2, 3	7

*Since this is a non-inverting gate, power drain is minimized by tying the inputs to gates not under test to V_{RH}.

MC3029



This device is a dual 3-input/3-output series-terminated NAND line driver that minimizes switching transients on long lines by approximating line impedance. Two outputs are provided through 75-ohm resistors for use when driving 93 to 120-ohm lines. These outputs should be paralleled when driving 50 to 93-ohm lines. In addition, an output is provided directly at the gate output node for driving adjacent gates.



Positive Logic: 4, 5, 6 = $\overline{1 \cdot 2 \cdot 3}$

Negative Logic: 4, 5, 6 = $\overline{1 + 2 + 3}$

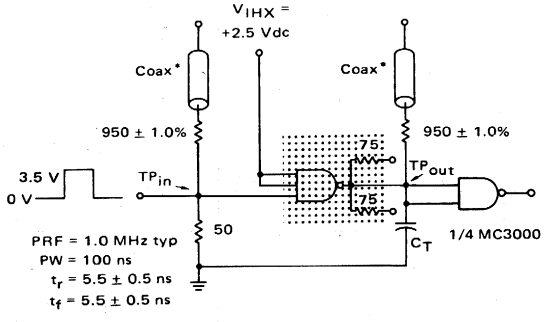
Input Loading Factor = 1

Output Loading Factor, Direct Output (Pins 6 and 8) = 10 Minus The Number of Resistor-Terminated Outputs Being Used.

Output Loading Factor, Resistors (Pins 4, 5, 9 and 10) = 1

Total Power Dissipation = 44 mW typ/pkg
Propagation Delay Time = 6.0 ns typ

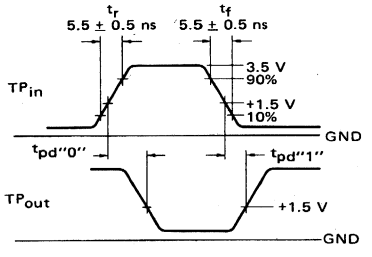
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

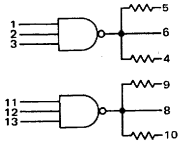
C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one line driver. The other line driver is tested in the same manner. Further, test procecures are shown for only one input of the line driver under test. To complete testing sequence through remaining inputs.



@Test Temperature	TEST CURRENT/VOLTAGE VALUES																						
	mA											Volts											
	$I_{OL\,1A}$	$I_{OL\,1B}$	$I_{OL\,1C}$	$I_{OL\,2A}$	$I_{OL\,2B}$	$I_{OL\,2C}$	$I_{OH\,A}$	$I_{OH\,B}$	$I_{OH\,C}$	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	
0°C	15.2	1.9	1.9	18.4	2.3	2.3	-1.8	-0.1	-0.1	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	-		
+25°C	15.2	1.9	1.9	18.4	2.3	2.3	-1.8	-0.1	-0.1	1.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	2.5		
+75°C	15.2	1.9	1.9	18.4	2.3	2.3	-1.8	-0.1	-0.1	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	-		

Characteristic	Symbol	Pin Under Test	MC3029 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT / VOLTAGE APPLIED TO PINS LISTED BELOW: $I_{OL\,1A}$	$I_{OL\,1B}$	$I_{OL\,1C}$	$I_{OL\,2A}$	$I_{OL\,2B}$	$I_{OL\,2C}$	$I_{OH\,A}$	$I_{OH\,B}$	$I_{OH\,C}$	I_{in}	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	V_{IHX}	Gnd
Input																														
Forward Current	I_{F1}	1	-	-1.9	-	-1.9	-	-1.9	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2,3	-	-	14	-	-	7*
	I_{F2}	1	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2,3	-	-	-	14	-	7*
Leakage Current	I_R	1	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	14	-	2, 3, 7*
Breakdown Voltage	BV_{in}	1	-	-	5.5	-	-	-	Vdc	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	14	-	2, 3, 7*
Clamp Voltage	V_D	1	-	-	-	-1.5	-	-	Vdc	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	14	-	-	7*
Output																														
Output Voltage	V_{OL1}	6	-	0.4	-	0.4	-	0.4	Vdc	6	5	4	-	-	-	-	-	-	-	-	-	1	-	-	2,3	-	-	14	-	-	7*
	V_{OL2}	6	-	0.4	-	0.4	-	0.4	Vdc	-	-	-	6	4	5	-	-	-	-	-	-	1	-	-	2,3	-	-	-	14	-	7*
	V_{OL3}	5	-	0.5	-	0.5	-	0.5	Vdc	6	5	4	-	-	-	-	-	-	-	-	-	1	-	-	2,3	-	-	14	-	-	7*
	V_{OL4}	5	-	0.5	-	0.5	-	0.5	Vdc	-	-	-	6	4	5	-	-	-	-	-	-	1	-	-	2,3	-	-	-	14	-	7*
	V_{OH}	6	2.5	-	2.5	-	2.5	-	Vdc	-	-	-	-	-	-	6	4	5	-	-	1	-	-	-	2,3	-	-	14	-	-	7*
Short-Circuit Current	I_{SC}	6	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 3, 6, 7*
Power Requirements (Total Device)																														
Maximum Power Supply Current	I_{max}	14	-	-	-	12	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	1, 2, 3, 7, 11, 12, 13
Power Supply Drain	I_{PDH}	14	-	18	-	18	-	18	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1, 2, 3, 11, 12, 13	-	14	-	-	-	7
	I_{PDL}	14	-	9	-	9	-	9	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1, 2, 3, 7, 11, 12, 13
Switching Parameters										Pulse In	Pulse Out																			
Turn-On Delay	$t_{pd"0"}$	1, 6	-	-	-	10	-	-	ns	1	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	2, 3	7*
Turn-Off Delay	$t_{pd"1"}$	1, 6	-	-	-	10	-	-	ns	1	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	2, 3	7*

*Since this is an inverting gate, power drain is minimized by grounding the inputs to gates not under test.

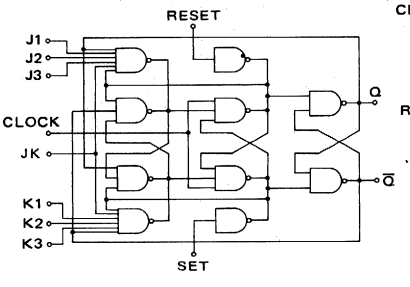
"AND" J-K FLIP-FLOP

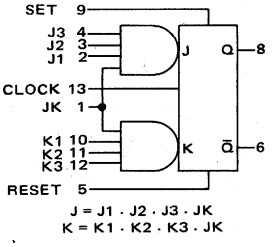
MC3050

This J-K flip-flop triggers on the positive edge of the clock. An AND input gating configuration formed by three J inputs ANDed together and three K inputs ANDed together, minimizes the requirements for external gating. The enable input (JK) consists of a J and a K input internally connected together. This input provides gating for the J and K inputs or an additional logic input for use in counters or other applications. A direct SET and RESET are provided to permit presetting data, such as initial conditions into the flip-flop. The direct SET and RESET fully override the clock; i.e., the direct SET and RESET control the operation of the flip-flop regardless of the state of the clock.

Information may be applied to, or changed at the J and K inputs any time in a clock cycle, except during the interval of time between the Set-up and Hold times. The inputs are inhibited when the clock is high; data is entered into the input steering section of the flip-flop when the clock goes low. The input steering section of the flip-flop continually reflects the input state when the clock is low. Data present during the time interval between the Set-up and Hold times is transferred to the bistable section on the positive edge of the clock and the outputs Q and $\bar{Q}$ respond accordingly. The flip-flop can be set or reset directly by applying the high state to the SET or RESET inputs.

LOGIC DIAGRAM





$J = J1 \cdot J2 \cdot J3 \cdot JK$

$K = K1 \cdot K2 \cdot K3 \cdot JK$

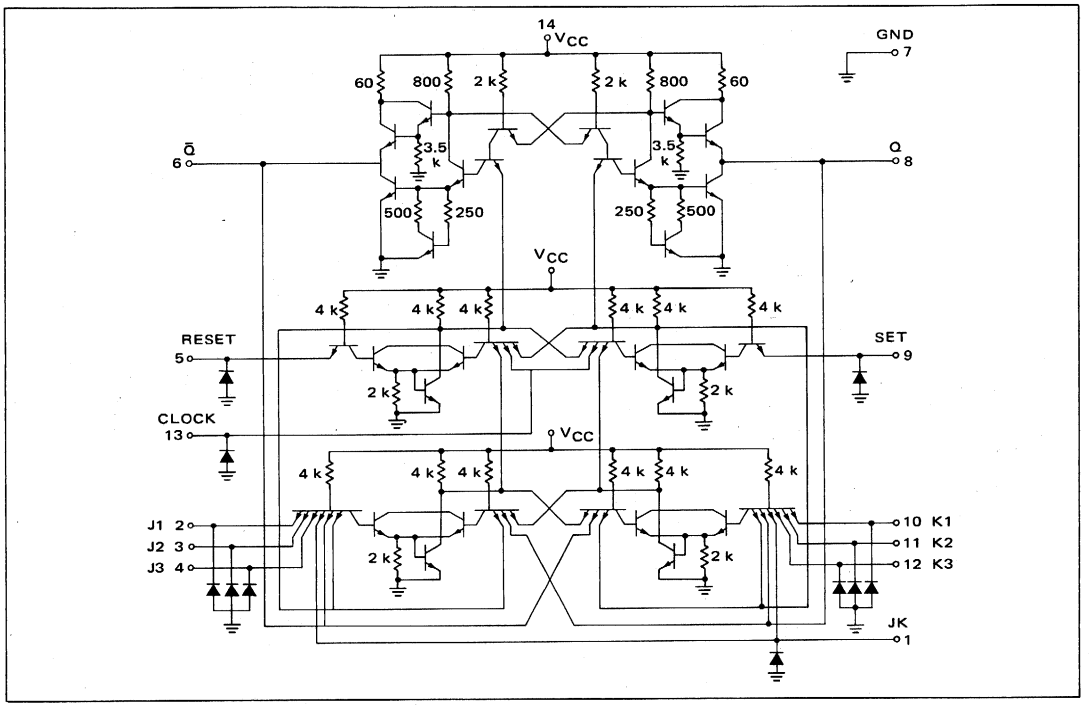
TRUTH TABLE

J	K	Q^n	Q^{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Input Loading Factors:
J, K, SET, RESET = 0.6
CLOCK, JK = 1.2

Output Loading Factor = 10

Typical Characteristics (V_{CC} = 5.0 V, T_A = 25°C)
- Total Power Dissipation = 80 mW/pkg
- Toggle Frequency = 40 MHz
- Logical "1" Setup Time = 10 ns
- Logical "0" Setup Time = 5.0 ns
- Logical "1" and "0" Hold Time = 5.0 ns
- t_{pd} "0" = 12 ns
- t_{pd} "1" = 14 ns



OPERATING CHARACTERISTICS

High state data must be present 17 ns prior to the rise of the clock and remain 5.0 ns after the clock signal rises.

Positive edge triggering: When the clock goes from the low state to the high state, the information in the input steering section is transferred to the bistable section.

The direct SET and RESET inputs may be used any time, regardless of the state of the clock. If these inputs are not used THEY MUST BE TIED TO GROUND.

Unused Inputs:

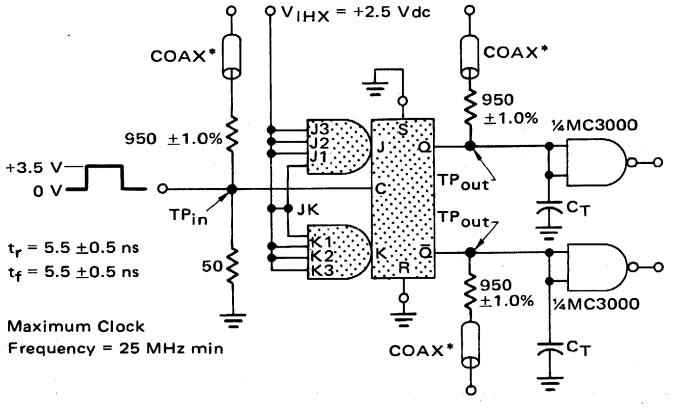
JK input MUST be in the high state to enable the clocked inputs. When the JK input is not used, it should be tied to a voltage between 2.0 and 5.5 Vdc.

Unused J inputs should be tied to used J inputs, the used JK input, $\overline{Q}$, or a voltage between 2.0 and 5.5 Vdc.

Unused K inputs should be tied to used K inputs, the used JK input, Q, or a voltage between 2.0 and 5.5 Vdc.

Unused SET and RESET inputs MUST be tied to ground.

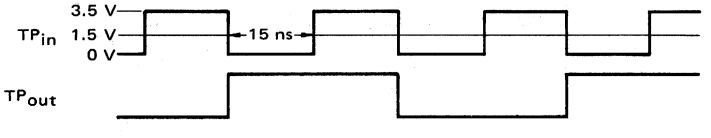
FIGURE 1 – MAXIMUM CLOCK FREQUENCY TEST CIRCUIT



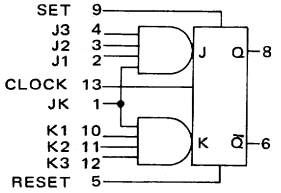
*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

WAVEFORMS AND DEFINITIONS



ELECTRICAL CHARACTERISTICS



@ Test Temperature	TEST CURRENT/VOLTAGE VALUES													
	mA					Volts								
	I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}
0°C	23	-2.0	-	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5
+25°C	23	-2.0	1.0	2.0	10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5
+75°C	23	-2.0	-	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5

Characteristic	Symbol	Pin Under Test	MC3050 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT/VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	Gnd
Input																								
Forward Current	I_{FJ}	2	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	2	-	1,3,4,5	-	-	-	14	7,9,13
		3	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	3	-	1,2,4,5	-	-	-	↓	↓
		4	-		-		-			-	-	-	-	-	-	-	4	-	1,2,3,5	-	-	-		
	I_{FK}	10	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	10	-	1,9,11,12	-	-	-	14	5,7,13
		11	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	11	-	1,9,10,12	-	-	-	↓	↓
		12	-		-		-			-	-	-	-	-	-	-	12	-	1,9,10,11	-	-	-		
	I_{FC}	13	-	-3.0	-	-3.0	-	-3.0	mAdc	-	-	-	-	-	-	-	13	-	-	-	-	-	14	1,5,7,9
	I_{FJK}	1	-	-3.0	-	-3.0	-	-3.0	mAdc	-	-	-	-	-	-	-	1	-	2,3,4,10,11,12	-	-	-	14	5,7,9,13
	I_{FS}	9	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	9	-	5	-	-	-	14	7
	I_{FR}	5	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	5	-	9	-	-	-	14	7
Leakage Current	I_{RJ}	2	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	2	9	-	-	-	14	1,3,4,5,7
		3	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	-	3	↓	-	-	-	↓	1,2,4,5,7
		4	-		-		-			-	-	-	-	-	-	-	-	4		-	-	-		1,2,3,5,7
	I_{RK}	10	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	10	5	-	-	-	14	1,7,9,11,12
		11	-	↓	-	↓	-	↓	↓	-	-	-	-	-	-	-	-	11	↓	-	-	-	↓	1,7,9,10,12
		12	-		-		-			-	-	-	-	-	-	-	-	12		-	-	-		1,7,9,10,11
	I_{RC}	13	-	110	-	110	-	110	μAdc	-	-	-	-	-	-	-	-	13	1,2,3,4,5,10,11,12	-	-	-	14	7,9
	I_{RJK}	1	-	110	-	110	-	110	μAdc	-	-	-	-	-	-	-	-	1	9	-	-	-	14	2,3,4,5,7,10,11,12
	I_{RS}	9	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	9	-	-	-	-	14	7
	I_{RR}	5	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	5	-	-	-	-	14	7

ELECTRICAL CHARACTERISTICS (continued)

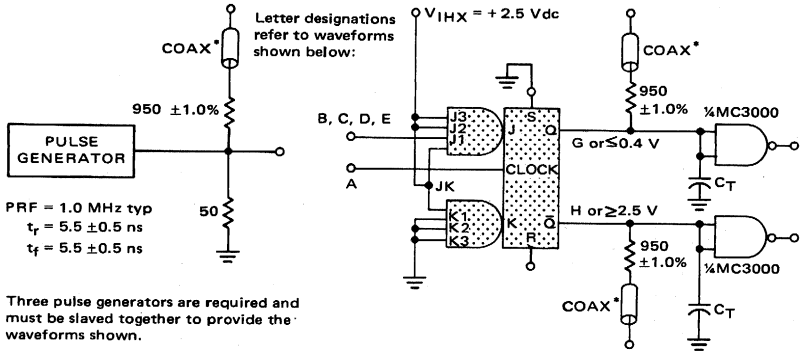
@ Test Temperature	TEST CURRENT/VOLTAGE VALUES													
	mA					Volts								
	I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}
0°C	23	-2.0	-	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5
+25°C	23	-2.0	1.0	2.0	10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5
+75°C	23	-2.0	-	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5

Characteristic	Symbol	Pin Under Test	MC3050 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT/VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	Gnd
Breakdown Voltage	BV_{in}	2	-	-	5.5	-	-	-	Vdc	-	-	2	-	-	-	-	-	-	9	-	-	-	14	1,3,4,5,7
		3	-	-	↓	-	-	-	↓	-	-	3	-	-	-	-	-	-	↓	-	-	-	↓	1,2,4,5,7
		4	-	-	↓	-	-	-	↓	-	-	4	-	-	-	-	-	-	↓	-	-	-	↓	1,2,3,5,7
		10	-	-	↓	-	-	-	↓	-	-	10	-	-	-	-	-	-	5	-	-	-	↓	1,7,9,11,12
		11	-	-	↓	-	-	-	↓	-	-	11	-	-	-	-	-	-	↓	-	-	-	↓	1,7,9,10,12
		12	-	-	↓	-	-	-	↓	-	-	12	-	-	-	-	-	-	↓	-	-	-	↓	1,7,9,10,11
		13	-	-	↓	-	-	-	↓	-	-	-	13	-	-	-	-	-	1,2,3,4,5,10,11,12	-	-	-	↓	7,9
		1	-	-	↓	-	-	-	↓	-	-	-	1	-	-	-	-	-	9	-	-	-	↓	2,3,4,5,7,10,11,12
		9	-	-	↓	-	-	-	↓	-	-	9	-	-	-	-	-	-	-	-	-	-	↓	7
		5	-	-	↓	-	-	-	↓	-	-	5	-	-	-	-	-	-	-	-	-	-	↓	7
Clamp Voltage	V_D	2	-	-	-	-1.5	-	-	Vdc	-	-	-	-	2	-	-	-	-	-	-	-	14	-	7
		3	-	-	-	↓	-	-	↓	-	-	-	-	3	-	-	-	-	-	-	-	↓	-	↓
		4	-	-	-	↓	-	-	↓	-	-	-	-	4	-	-	-	-	-	-	-	↓	-	↓
		10	-	-	-	↓	-	-	↓	-	-	-	-	10	-	-	-	-	-	-	-	↓	-	↓
		11	-	-	-	↓	-	-	↓	-	-	-	-	11	-	-	-	-	-	-	-	↓	-	↓
		12	-	-	-	↓	-	-	↓	-	-	-	-	12	-	-	-	-	-	-	-	↓	-	↓
		13	-	-	-	↓	-	-	↓	-	-	-	-	13	-	-	-	-	-	-	-	↓	-	↓
		1	-	-	-	↓	-	-	↓	-	-	-	-	1	-	-	-	-	-	-	-	↓	-	↓
		9	-	-	-	↓	-	-	↓	-	-	-	-	9	-	-	-	-	-	-	-	↓	-	↓
		5	-	-	-	↓	-	-	↓	-	-	-	-	5	-	-	-	-	-	-	-	↓	-	↓
Output Output Voltage	V_{OL}	6	-	0.4	-	0.4	-	0.4	Vdc	6	-	-	-	-	5	9	-	-	-	-	-	-	14	7,13
		8	-	0.4	-	0.4	-	0.4	Vdc	8	-	-	-	-	9	5	-	-	-	-	-	-	14	7,13
	V_{OH}	6	2.5	-	2.5	-	2.5	-	Vdc	-	6	-	-	-	9	5	-	-	-	-	-	14	-	7,13
		8	2.5	-	2.5	-	2.5	-	Vdc	-	8	-	-	-	5	9	-	-	-	-	-	14	-	7,13
Short-Circuit Current	I_{SC}	6	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	5	-	14	-	-	6,7,9
		8	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	9	-	14	-	-	5,7,8
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	35	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1,5,7,13
Power Supply Drain	I_{PD}	14	-	26	-	26	-	26	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	1,5,7,13

OPERATING CHARACTERISTICS (continued)

FIGURE 2 – SWITCHING TIME TEST CIRCUIT

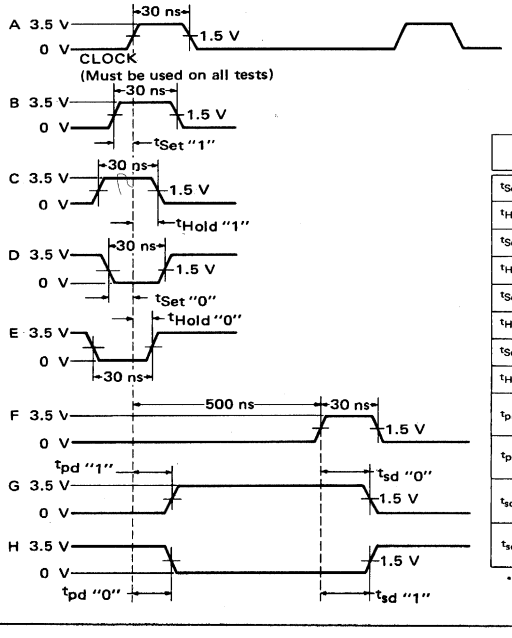
(For J inputs and RESET input; to test other inputs, refer to Test Procedures Chart)



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



TEST PROCEDURES CHART

TEST	INPUT J**	SET**	RESET**	K**	Q**	$\overline{Q}$**	LIMITS (ns) Min	Max
t_{Set} "1" J	B	Gnd	F	Gnd	G	H	-	17
t_{Hold} "1" J	C	Gnd	F	Gnd	G	H	-	0†
t_{Set} "0" J	D	Gnd	F	Gnd	≤0.4 V	≥2.5 V	-	5.0
t_{Hold} "0" J	E	Gnd	F	Gnd	≤0.4 V	≥2.5 V	-	0†
t_{Set} "1" K	Gnd	F	Gnd	B	H	G	-	17
t_{Hold} "1" K	Gnd	F	Gnd	C	H	G	-	0†
t_{Set} "0" K	Gnd	F	Gnd	D	≥ 2.5 V	≤0.4 V	-	5.0
t_{Hold} "0" K	Gnd	F	Gnd	E	≥ 2.5 V	≤0.4 V	-	0†
t_{pd} "1"	Delay from clock to Q during t_{Set} "1" J test. Delay from clock to $\overline{Q}$ during t_{Set} "1" K test.						8.0	30
t_{pd} "0"	Delay from clock to $\overline{Q}$ during t_{Set} "1" J test. Delay from clock to Q during t_{Set} "1" K test.						8.0	30
t_{sd} "1"	Delay from SET to Q during t_{Set} "1" K test. Delay from RESET to $\overline{Q}$ during t_{Set} "1" J test.						7.0	23
t_{sd} "0"	Delay from SET to $\overline{Q}$ during t_{Set} "1" K test. Delay from RESET to Q during t_{Set} "1" J test.						7.0	23

**Letters shown in these columns refer to waveforms at the left.
†t_{Hold} is typically a negative number.

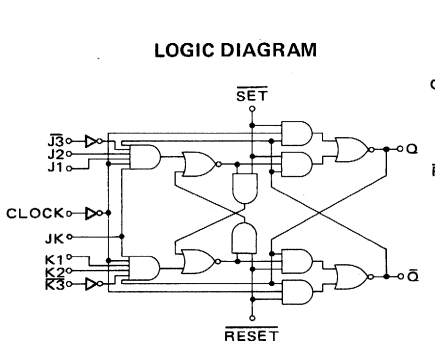
"AND" INPUT JJ̄-KK̄ FLIP-FLOP

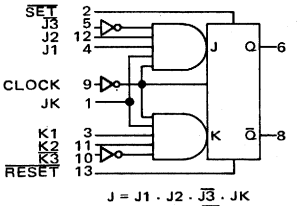
MC3052

The MC3052 is a master-slave J-K flip-flop that triggers on the positive edge of the clock. The flip-flop has an AND input configuration consisting of two J-inputs and a J̄-input ANDed together and two K-inputs and a K̄-input ANDed together. An enable input (JK) is also provided consisting of an additional J and K input internally connected together. This input provides gating in addition to the clock for the clocked inputs (J, J̄, K and K̄) or an additional logic input (JK) for use in counters or certain other applications. A direct $\overline{SET}$ and $\overline{RESET}$ are provided to enable presetting data into the flip-flop such as initial conditions. The direct $\overline{SET}$ and $\overline{RESET}$ control the operation of the flip-flop regardless of the state of the clock.

Information is normally applied to, or changed at, the clocked inputs while the clock is in the high state, since the inputs are inhibited under this condition. Information may be stored in the master flip-flop section when the clock goes low. Once input data has been stored in the master flip-flop section it cannot be removed (or changed) by means of the clocked inputs. The direct $\overline{SET}$ or $\overline{RESET}$ provide the only means of removing previously stored information. The state of the master flip-flop is transferred to the slave flip-flop section on the positive transition of the clock and the outputs respond accordingly. The flip-flop can be set or reset directly by applying the low state to the direct $\overline{SET}$ or $\overline{RESET}$ inputs.

LOGIC DIAGRAM





$J = J1 \cdot J2 \cdot \overline{J3} \cdot JK$

$K = K1 \cdot K2 \cdot \overline{K3} \cdot JK$

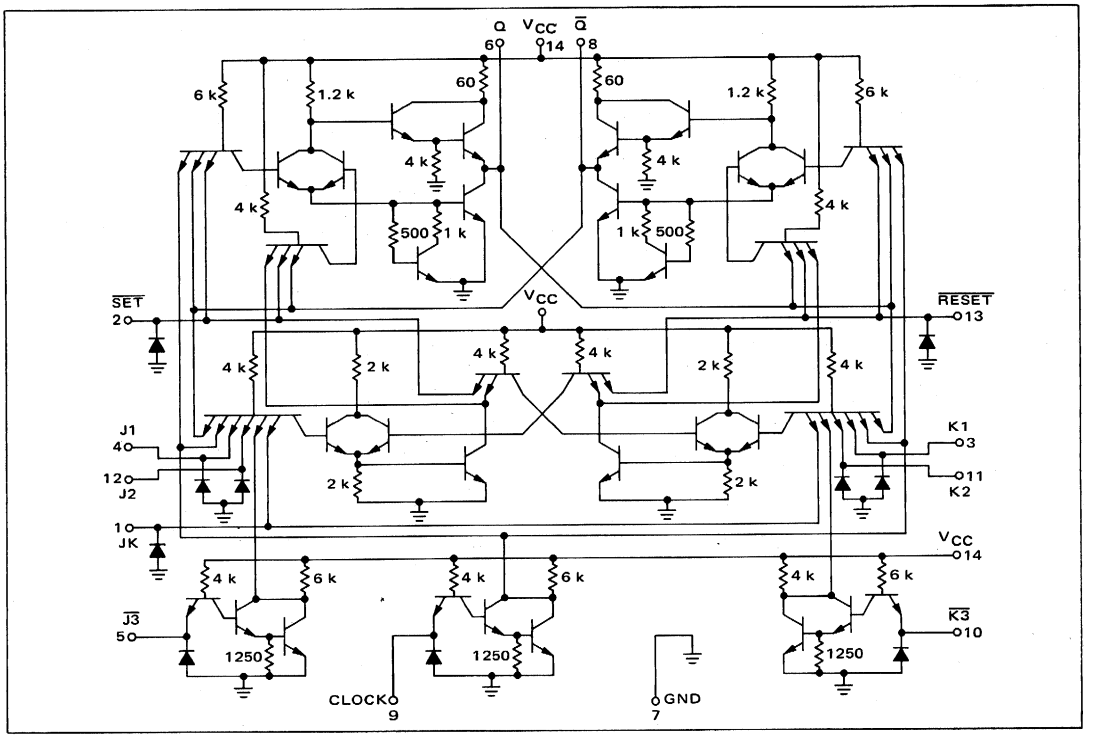
TRUTH TABLE

J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

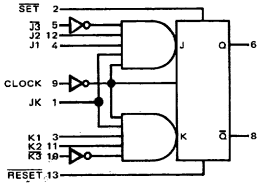
Input Loading Factors:
- JK = 1.3
- J, K, CLOCK = 0.6
- $\overline{SET}$, $\overline{RESET}$ = 2.0

Output Loading Factor = 10

Typical Characteristics:
(V_{CC} = 5.0 V; T_A = 25°C)
- Total Power Dissipation = 75 mW/pkg
- Toggle Frequency = 40 MHz
- Logical "1" Setup Time = 10 ns
- Logical "0" Hold Time = 8.0 ns
- t_{pd} "0" = 20 ns
- t_{pd} "1" = 12 ns



ELECTRICAL CHARACTERISTICS



@ Test Temperature	TEST CURRENT/VOLTAGE VALUES														
	mA					Volts									
	I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	
0°C	23	-2.0	-	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	
+25°C	23	-2.0	1.0	2.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	
+75°C	23	-2.0	-	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	

Characteristic	Symbol	Pin Under Test	MC3052 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT/VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	P_1*	Gnd
Input																									
Forward Current	I_{FJ}	4	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	4	-	1,12	-	-	-	14	-	5,7,9,13
		12	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	12	-	1,4	-	-	-	14	-	5,7,9,13
	I_{FK}	3	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	3	-	1,11	-	-	-	14	-	2,7,9,10
		11	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	11	-	1,3	-	-	-	14	-	2,7,9,10
	$I_{F\bar{J}}$	5	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	5	-	-	-	-	-	14	-	7
	$I_{F\bar{K}}$	10	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	10	-	-	-	-	-	14	-	7
	I_{FC}	9	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	9	-	-	-	-	-	14	-	7
	I_{FJK}	1	-	-3.0	-	-3.0	-	-3.0	mAdc	-	-	-	-	-	-	-	1	-	3,4,11,12	-	-	-	14	-	2,5,7,9,10,13
	$I_{F\bar{S}}$	2	-	-4.5	-	-4.5	-	-4.5	mAdc	-	-	-	-	-	-	-	2	-	-	-	-	-	14	-	7,9,13
	$I_{F\bar{R}}$	13	-	-4.5	-	-4.5	-	-4.5	mAdc	-	-	-	-	-	-	-	13	-	-	-	-	-	14	-	2,7,9
Leakage Current	I_{RJ}	4	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	4	5,9	-	-	-	14	-	1,2,7,12
		12	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	12	5,9	-	-	-	14	-	1,2,4,7
	I_{RK}	3	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	3	9,10	-	-	-	14	-	1,7,11,13
		11	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	11	9,10	-	-	-	14	-	1,3,7,13
	$I_{R\bar{J}}$	5	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	5	-	-	-	-	14	-	7
	$I_{R\bar{K}}$	10	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	10	-	-	-	-	14	-	7
	I_{RC}	9	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	9	-	-	-	-	14	-	7
	I_{RJK}	1	-	110	-	110	-	110	μAdc	-	-	-	-	-	-	-	-	1	5,9,10	-	-	-	14	-	3,4,6,7,8,11,12
	$I_{R\bar{S}}$	2	-	140	-	140	-	140	μAdc	-	-	-	-	-	-	-	-	2	1,4,10,12,13	-	-	-	14	9	3,5,7,11
	$I_{R\bar{R}}$	13	-	140	-	140	-	140	μAdc	-	-	-	-	-	-	-	-	13	1,2,3,5,11	-	-	-	14	9	4,7,10,12

*Pulse is used to set flip-flop in desired state. P_1 = 4.0 V (V_{RH}), 0 V

ELECTRICAL CHARACTERISTICS (continued)

@ Test Temperature	TEST CURRENT/VOLTAGE VALUES														
	mA					Volts									
	I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	
0°C	23	-2.0	-	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	
+25°C	23	-2.0	1.0	2.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	
+75°C	23	-2.0	-	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	

Characteristic	Symbol	Pin Under Test	MC3052 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT/VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	P_1*	Gnd
Breakdown Voltage	BV_{in}	4	-	-	5.5	-	-	-	Vdc	-	-	4	-	-	-	-	-	-	5,9	-	-	-	14	-	1,2,7,12
		12	-	-	↓	-	-	-	↓	-	-	12	-	-	-	-	-	-	5,9	-	-	-	↓	-	1,2,4,7
		3	-	-		-	-	-		-	-	3	-	-	-	-	-	-	9,10	-	-	-		-	1,7,11,13
		11	-	-		-	-	-		-	-	11	-	-	-	-	-	-	9,10	-	-	-		-	1,3,7,13
		1	-	-		-	-	-		-	-	-	1	-	-	-	-	-	2,5,9,10,13	-	-	-		-	3,4,6,7,8,11,12
		2	-	-		-	-	-		-	-	-	2	-	-	-	-	-	1,4,10,12,13	-	-	-		9	3,5,7,11
		13	-	-		-	-	-		-	-	-	13	-	-	-	-	-	1,2,3,5,11	-	-	-		9	4,7,10,12
		5	-	-		-	-	-		-	-	5	-	-	-	-	-	-	-	-	-	-		-	7
		9	-	-		-	-	-		-	-	9	-	-	-	-	-	-	-	-	-	-		-	7
		10	-	-	↓	-	-	-	↓	-	-	10	-	-	-	-	-	-	-	-	-	-	↓	-	7
Clamp Voltage	V_D	4	-	-	-	-1.5	-	-	Vdc	-	-	-	-	4	-	-	-	-	-	-	-	14	-	-	7
		12	-	-	-	↓	-	-	↓	-	-	-	-	12	-	-	-	-	-	-	-	↓	-	-	↓
		3	-	-	-		-	-		-	-	-	-	3	-	-	-	-	-	-	-		-	-	
		11	-	-	-		-	-		-	-	-	-	11	-	-	-	-	-	-	-		-	-	
		5	-	-	-		-	-		-	-	-	-	5	-	-	-	-	-	-	-		-	-	
		10	-	-	-		-	-		-	-	-	-	10	-	-	-	-	-	-	-		-	-	
		9	-	-	-		-	-		-	-	-	-	9	-	-	-	-	-	-	-		-	-	
		1	-	-	-		-	-		-	-	-	-	1	-	-	-	-	-	-	-		-	-	
		2	-	-	-		-	-		-	-	-	-	2	-	-	-	-	-	-	-		-	-	
		13	-	-	-	↓	-	-	↓	-	-	-	-	13	-	-	-	-	-	-	-	↓	-	-	↓
Output																									
Output Voltage	V_{OL}	6	-	0.4	-	0.4	-	0.4	Vdc	6	-	-	-	-	13	2	-	-	-	-	-	-	14	-	7,9
		8	-	0.4	-	0.4	-	0.4	Vdc	8	-	-	-	-	2	13	-	-	-	-	-	-	14	-	7,9
	V_{OH}	6	2.5	-	2.5	-	2.5	-	Vdc	-	6	-	-	-	2	13	-	-	-	-	-	14	-	-	7,9
		8	2.5	-	2.5	-	2.5	-	Vdc	-	8	-	-	-	13	2	-	-	-	-	-	14	-	-	7,9
Short-Circuit Current	I_{SC}	6	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	2,6,7
		8	-	-	-30	-100	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	7,8,13
Power Requirements (Total Device)																									
Maximum Power Current	I_{max}	14	-	-	-	42	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	1,2,3,4,5,7,9,10,11,12,13
Power Supply Drain	I_{PD}	14	-	30	-	30	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1,2,5,7,9,10

*Pulse is used to set flip-flop in desired state. P_1 = 4.0 V (V_{RH}), 0 V

OPERATING CHARACTERISTICS

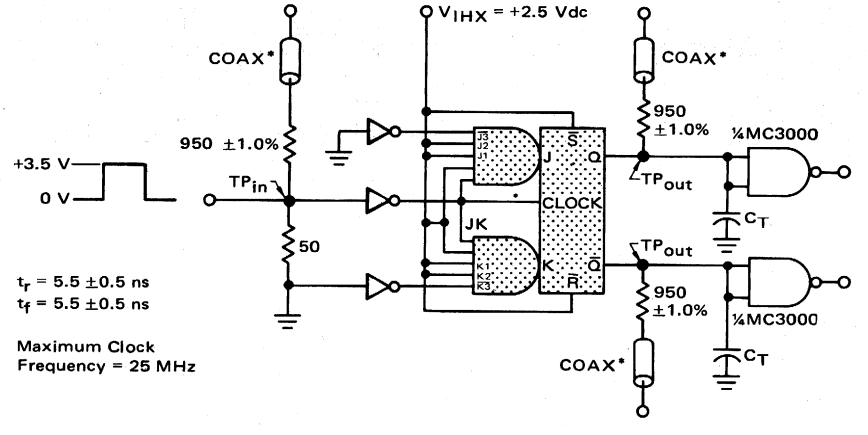
Data should be present prior to the negative clock transition. If data is changed from a "1" to a "0" while the clock is in the low state, the flip-flop will not recognize this new data state.

The application of a low level to the $\overline{SET}$ input sets Q high and low level on the $\overline{RESET}$ input resets Q low. These functions may be performed at any time without regard to the clock area.

Positive edge triggering — When the clock goes from the low to the high state, the information stored in the master flip-flop section is transferred to the slave flip-flop section thus appearing at the outputs. When the clock is in the high state, the inputs are inhibited.

Unused J, K, and JK inputs should be tied together with used inputs, to the internally connected output, or to a voltage between 2.0 and 5.5 Vdc. The unused $\overline{J}$ and $\overline{K}$ inputs must be tied to ground. The unused $\overline{SET}$ and $\overline{RESET}$ inputs should be tied to a voltage between 2.0 and 5.5 Vdc.

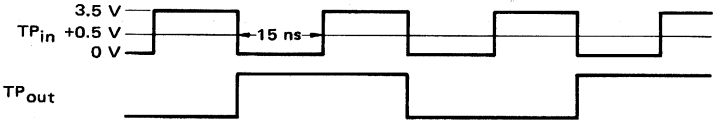
FIGURE 1 — MAXIMUM CLOCK FREQUENCY TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

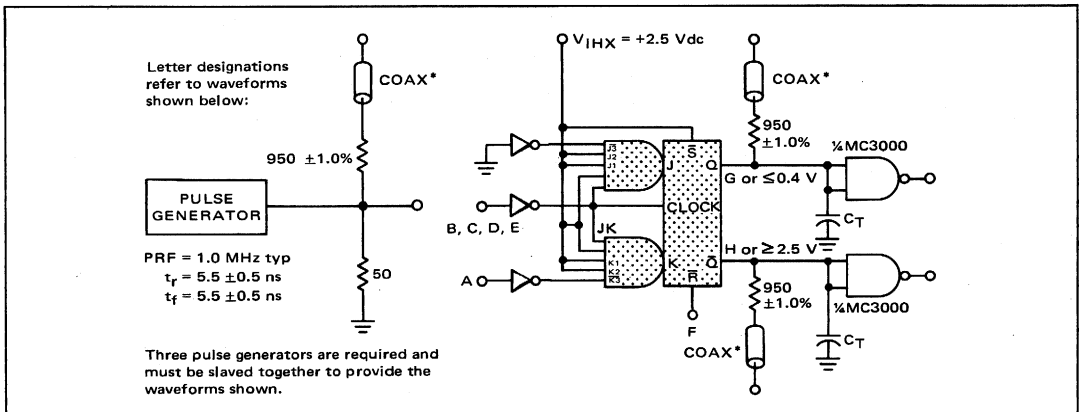
WAVEFORMS AND DEFINITIONS



OPERATING CHARACTERISTICS (continued)

FIGURE 2 – SWITCHING TIME TEST CIRCUIT

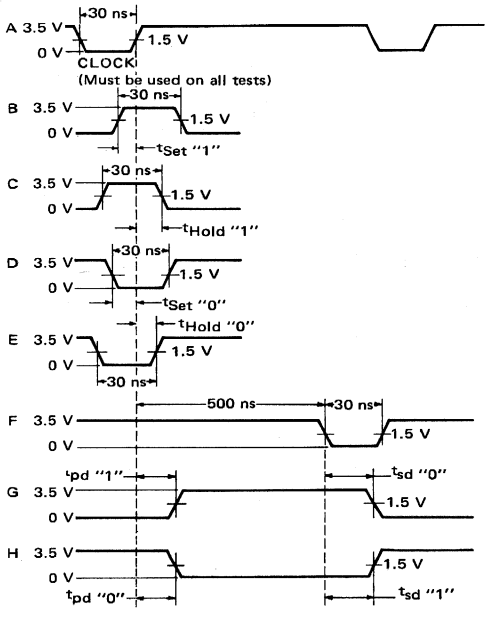
(For J inputs and $\overline{\text{RESET}}$ input; to test other inputs, refer to Test Procedures Chart)



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



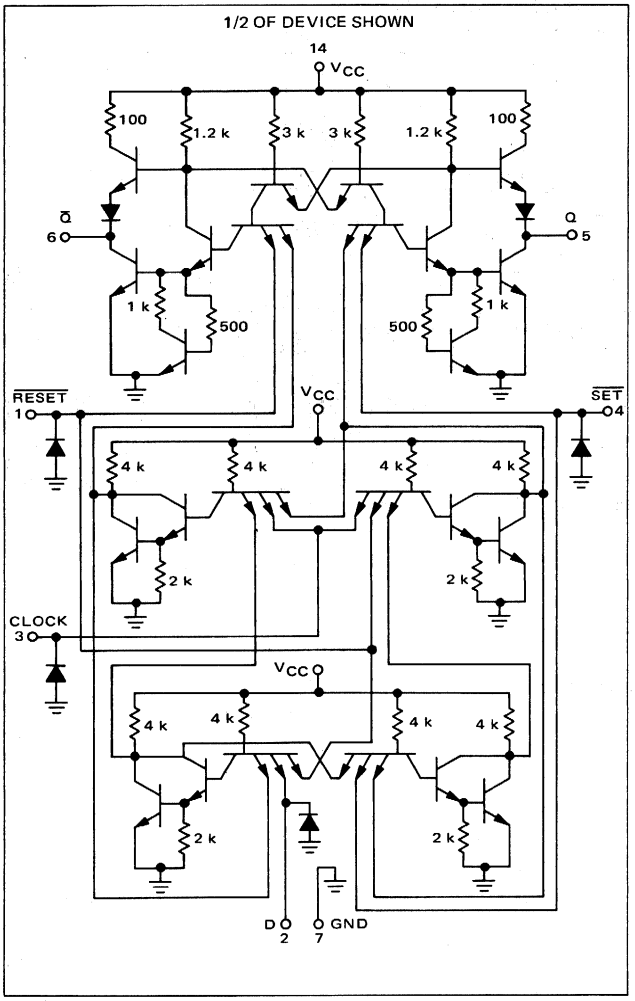
TEST PROCEDURES CHART

TEST	INPUT J*	INPUT $\overline{J}$*	INPUT $\overline{SET}$*	INPUT $\overline{RESET}$*	INPUT K*	INPUT $\overline{K}$*	Q*	$\overline{Q}$*	LIMITS (ns) Min	LIMITS (ns) Max
t_{Set} "1" J	C	Gnd	2.5 V	F	Gnd	Gnd	G	H	–	15
t_{Hold} "0" J	B	Gnd	2.5 V	F	Gnd	Gnd	≤0.4 V	≥2.5 V	–	–3.0
t_{Set} "1" K	Gnd	Gnd	F	2.5 V	C	Gnd	H	G	–	15
t_{Hold} "0" K	Gnd	Gnd	F	2.5 V	B	Gnd	≥2.5 V	≤0.4 V	–	–3.0
t_{Set} "1" $\overline{J}$	2.5 V	E	2.5 V	F	2.5 V	Gnd	G	H	–	15
t_{Hold} "0" $\overline{J}$	2.5 V	D	2.5 V	F	2.5 V	Gnd	≤0.4 V	≥2.5 V	–	–3.0
t_{Set} "1" $\overline{K}$	2.5 V	Gnd	F	2.5 V	2.5 V	E	H	G	–	15
t_{Hold} "0" $\overline{K}$	2.5 V	Gnd	F	2.5 V	2.5 V	D	≥2.5 V	≤0.4 V	–	–3.0
t_{pd} "1"	Delay from clock to Q during t_{Set} "1" J test. Delay from clock to $\overline{Q}$ during t_{Set} "1" K test.								8	20
t_{pd} "0"	Delay from clock to $\overline{Q}$ during t_{Set} "1" J test. Delay from clock to Q during t_{Set} "1" K test.								14	28
t_{sd} "1"	Delay from $\overline{SET}$ to Q during t_{Set} "1" K test. Delay from $\overline{RESET}$ to $\overline{Q}$ during t_{Set} "1" J test.								–	18
t_{sd} "0"	Delay from $\overline{SET}$ to $\overline{Q}$ during t_{Set} "1" K test. Delay from $\overline{RESET}$ to Q during t_{Set} "1" J test.								–	25

*Letters shown in these columns refer to waveforms.

DUAL TYPE D FLIP-FLOP

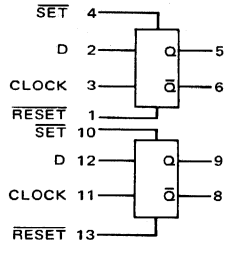
MC3060



The MC3060 dual flip-flop triggers on the positive edge of the clock and performs the Type D flip-flop logic function. This device consists of two completely independent Type D flip-flops, both having direct $\overline{SET}$ and $\overline{RESET}$ inputs for asynchronous operations such as parallel data entry in shift register applications.

Information may be applied to, or changed at, the D inputs any time during the clock cycle except during the time interval between the Set-up and Hold times. The clocked inputs are inhibited when the clock is high and data may be applied to the input steering section of the flip-flop when the clock goes low. The input steering section continually reflects the input state being applied when the clock is low. The information present at the inputs during the time interval between the Set-up and Hold times is transferred to the bistable section on the positive edge of the clock, and the outputs Q and $\overline{Q}$ respond accordingly.

The flip-flop can also be set or reset directly at any time, regardless of the state of the clock, by applying a low state to the direct $\overline{SET}$ or $\overline{RESET}$ inputs.

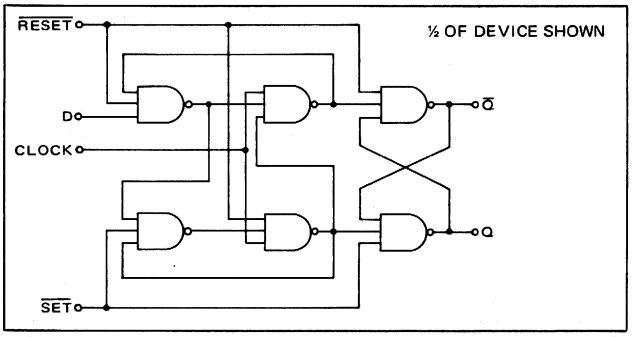


TRUTH TABLE

D	Q^n	Q^{n+1}
0	0	0
0	1	0
1	0	1
1	1	1

$Q^{n+1} = D^n$

LOGIC DIAGRAM



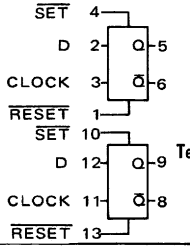
Input Loading Factors:
- $\overline{SET}$ = 1.0
- $\overline{RESET}$ = 1.5
- CLOCK= 1.4
- D = 0.6

Output Loading Factor = 10

Typical Characteristics: (V_{CC} = 5.0 V, T_A = 25°C)
- Total Power Dissipation = 120 mW/pkg
- Toggle Frequency = 30 MHz
- Logical "1" Setup Time = 10 ns
- Logical "0" Setup Time = 5.0 ns
- Logical "1" and "0" Hold Times = 5.0 ns
- t_{pd} "0" = 17 ns
- t_{pd} "1" = 15 ns

ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one flip-flop. The other flip-flop is tested in the same manner.



@ Test Temperature	TEST CURRENT/VOLTAGE VALUES													
	mA					Volts								
	I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}
0°C	23	-2.0	-	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5
+25°C	23	-2.0	1.0	2.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5
+75°C	23	-2.0	-	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5

Characteristic	Symbol	Pin Under Test	MC3060 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT/VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	P_1*	Gnd
Input																									
Forward Current	I_{FC}	3	-	-3.0	-	-3.0	-	-3.0	mAdc	-	-	-	-	-	-	-	3	-	1	-	-	-	14	-	2,4,7,11
	I_{FD}	2	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	2	-	1,4	-	-	-	14	-	3,7,11
	I_{FS}	4	-	-2.3	-	-2.3	-	-2.3	mAdc	-	-	-	-	-	-	-	4	-	1	-	-	-	14	-	2,3,7,11
	I_{FR}	1	-	-3.4	-	-3.4	-	-3.4	mAdc	-	-	-	-	-	-	-	1	-	2,4	-	-	-	14	-	3,7,11
Leakage Current	I_{RC}	3	-	110	-	110	-	110	μAdc	-	-	-	-	-	-	-	-	3	4	-	-	-	14	-	1,2,7,11
	I_{RD}	2	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	2	3,4	-	-	-	14	-	1,7,11
	I_{RS}	4	-	110	-	110	-	110	μAdc	-	-	-	-	-	-	-	-	4	1,2	-	-	-	14	3	7,11
	I_{RR}	1	-	140	-	140	-	140	μAdc	-	-	-	-	-	-	-	-	1	4	-	-	-	14	3	2,7,11
Breakdown Voltage	BV_{in}	3	-	-	5.5	-	-	-	Vdc	-	-	-	3	-	-	-	-	-	4	-	-	-	14	-	1,2,7,11
		2	-	-	↓	-	-	-	↓	-	-	2	-	-	-	-	-	-	3,4	-	-	-	↓	-	1,7,11
		4	-	-		-	-	-		-	-	-	4	-	-	-	-	-	1,2	-	-	-		3	7,11
		1	-	-		-	-	-		-	-	-	1	-	-	-	-	-	4	-	-	-		3	2,7,11
Clamp Voltage	V_D	3	-	-	-	-1.5	-	-	Vdc	-	-	-	-	3	-	-	-	-	-	-	-	14	-	-	7,11
		2	-	-	-	↓	-	-	↓	-	-	-	-	2	-	-	-	-	-	-	-	↓	-	-	↓
		4	-	-	-		-	-		-	-	-	-	4	-	-	-	-	-	-	-		-	-	
		1	-	-	-	↓	-	-	↓	-	-	-	-	1	-	-	-	-	-	-	-	↓	-	-	↓
Output																									
Output Voltage	V_{OL}	6	-	0.4	-	0.4	-	0.4	Vdc	6	-	-	-	-	4	1	-	-	-	-	-	-	14	-	2,3,7,11
		5	-	0.4	-	0.4	-	0.4	Vdc	5	-	-	-	-	1	4	-	-	-	-	-	-	14	-	2,3,7,11
	V_{OH}	6	2.5	-	2.5	-	2.5	-	Vdc	-	6	-	-	-	1	4	-	-	-	-	-	14	-	-	2,3,7,11
		5	2.5	-	2.5	-	2.5	-	Vdc	-	5	-	-	-	4	1	-	-	-	-	-	14	-	-	2,3,7,11
Short-Circuit Current	I_{SC}	6	-	-	-20	-60	-	-	mAdc	-	-	-	-	-	-	4	1	-	-	-	14	-	-	-	6,7,11
		5	-	-	-20	-60	-	-	mAdc	-	-	-	-	-	-	1	4	-	-	-	14	-	-	-	5,7,11
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	42	-	-	mAdc	-	-	-	-	-	-	-	-	-	1,13	14	-	-	-	-	3,4,7,10,11
Power Supply Drain	I_{PD}	14	-	29	-	29	-	29	mAdc	-	-	-	-	-	-	-	-	-	4,10	-	14	-	-	-	1,3,7,11,13

* Pulse is used to set flip-flop in desired state. $P_1 =$ 4.0 V (V_{RH}), 0 V. If pin is also in another column, the pin must be returned to that voltage or current for measurement.

OPERATING CHARACTERISTICS

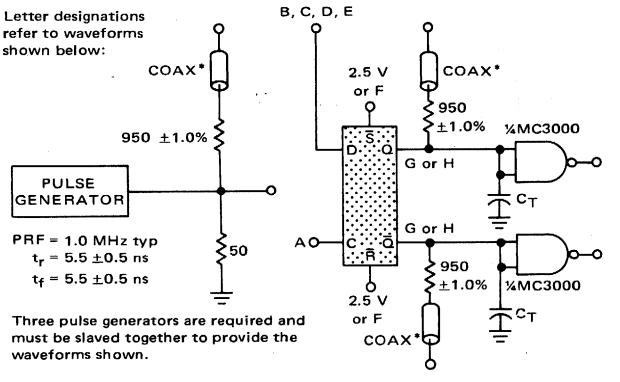
Data must be present 15 ns prior to the rise of the clock and remain 5.0 ns after the clock signal rises.

The direct $\overline{SET}$ and $\overline{RESET}$ inputs may be used at any time as they completely override the clock.

Positive edge triggering: When the clock goes from the low to the high state, the information in the input steering section is transferred to the bistable section.

Unused inputs should be tied to a voltage between 2.0 and 5.5 Vdc.

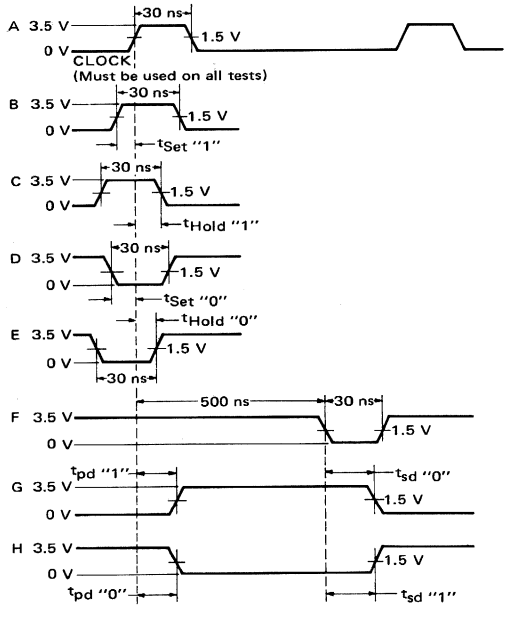
SWITCHING TIME TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



TEST PROCEDURES CHART

TEST	INPUT D*	INPUT $\overline{SET}$*	INPUT $\overline{RESET}$*	Q*	$\overline{Q}$*	LIMITS (ns) Min	LIMITS (ns) Max
t_{Set} "1" D	B	2.5 V	F	G	H	–	15
t_{Hold} "1" D	C	2.5 V	F	G	H	–	5.0
t_{Set} "0" D	D	F	2.5 V	H	G	–	15
t_{Hold} "0" D	E	F	2.5 V	H	G	–	5.0
t_{pd} "1"	Delay from clock to Q during t_{Set} "1" D test. Delay from clock to $\overline{Q}$ during t_{Set} "0" D test.					10	25
t_{pd} "0"	Delay from clock to Q during t_{Set} "0" D test. Delay from clock to $\overline{Q}$ during t_{Set} "1" D test.					10	25
t_{sd} "1"	Delay from $\overline{SET}$ to Q during t_{Set} "0" D test. Delay from $\overline{RESET}$ to $\overline{Q}$ during t_{Set} "1" D test.					5.0	20
t_{sd} "0"	Delay from $\overline{SET}$ to $\overline{Q}$ during t_{Set} "0" D test. Delay from $\overline{RESET}$ to Q during t_{Set} "1" D test.					5.0	20

*Letters shown in these columns refer to waveforms at left.

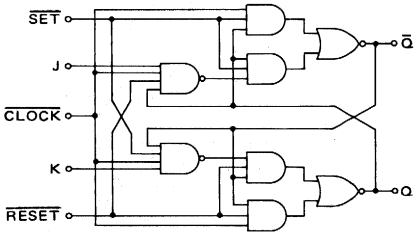
MC3061

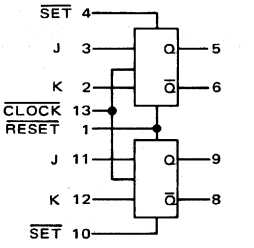
The MC3061 dual JK flip-flop triggers on the negative edge of the clock. Each flip-flop is provided with a separate direct $\overline{SET}$ input in addition to the common direct $\overline{RESET}$ input. These direct inputs provide a means of resetting a group of flip-flops such as a register which may be followed by the presetting of a data pattern. The clock input for this device is common for both flip-flops, making it particularly useful in registers or other common clock applications.

Data may be applied to or changed at, the clocked inputs at any time during the clock cycle, except during the time interval between the Setup and Hold times. The inputs are inhibited when the clock is low and enabled when the clock rises. The input steering network continuously responds to input information when the clock is high. The data state at the inputs throughout the interval between the Set-up and Hold time is stored in the flip-flop when the clock falls. Each flip-flop may be set at any time without regard to the clock state by applying a low level to the $\overline{SET}$ input. In addition, both flip-flops may be reset simultaneously by using the common $\overline{RESET}$ in a similar manner.

LOGIC DIAGRAM

1/2 OF DEVICE SHOWN,
$\overline{RESET}$ AND $\overline{CLOCK}$ COMMON TO BOTH





Input Loading Factors:
$\overline{SET}$ = 1.6
$\overline{RESET}$, $\overline{CLOCK}$ = 3.2
J, K = 0.6

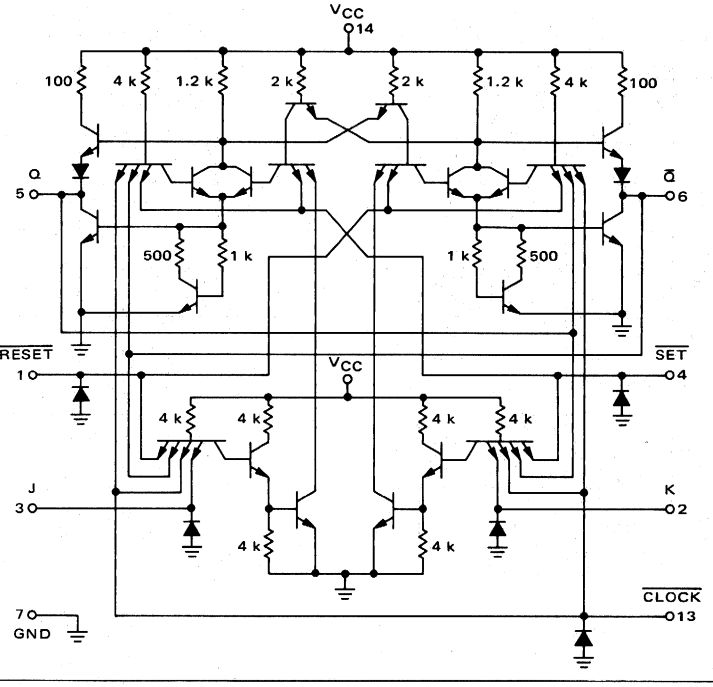
Output Loading Factor = 10

J-K TRUTH TABLE

J	K	Q^n	Q^{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Typical Characteristics
(V_{CC} = 5.0 V; T_A = 25°C)

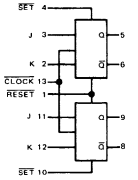
Total Power Dissipation = 100 mW/pkg
Toggle Frequency = 50 MHz
Logical "1" Setup Time = 8.0 ns
Logical "0" Setup Time = 8.0 ns
Logical "1" and "0" Hold Times = 0 ns
t_{pd} "0" = 12 ns
t_{pd} "1" = 12 ns



1/2 OF CIRCUIT
SHOWN ($\overline{RESET}$ AND $\overline{CLOCK}$
COMMON TO BOTH)

ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one flip-flop plus the inputs common to both flip-flops. To complete testing, sequence through the remaining inputs in the same manner.



@ Test Temperature	TEST CURRENT/VOLTAGE VALUES														
	mA					Volts									
	I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	
0°C	23	-2.0	-	-	-	1.1	2.0	0.4	2.5	4.0	-	5.0	4.5	5.5	
+25°C	23	-2.0	1.0	2.0	-10	1.1	1.8	0.4	2.5	4.0	7.0	5.0	4.5	5.5	
+75°C	23	-2.0	-	-	-	0.9	1.8	0.4	2.5	4.0	-	5.0	4.5	5.5	

Characteristic	Symbol	Pin Under Test	MC3061 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT/VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_{IL}	V_{IH}	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	P_1*	Gnd
Input																									
Forward Current	I_{FJ}	3	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	3	-	1,4,13	-	-	-	14	1	2,7,10
	I_{FK}	2	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	-	-	2	-	1,4,13	-	-	-	14	4	3,7,10
	$I_{F\overline{R}}$	1	-	-3.5	-	-3.5	-	-3.5	mAdc	-	-	-	-	-	-	-	1	-	3,4,13	-	-	-	14	-	2,7,10
	$I_{F\overline{S}}$	4	-	-1.8	-	-1.8	-	-1.8	mAdc	-	-	-	-	-	-	-	4	-	1,2,13	-	-	-	14	-	3,7,10
	$I_{F\overline{C}}$	13	-	-5.7	-	-5.7	-	-5.7	mAdc	-	-	-	-	-	-	-	13	-	1,2,3,11,12	-	-	-	14	4,10	7
Leakage Current	I_{RJ}	3	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	3	2,4	-	-	-	14	-	1,7,10,13
	I_{RK}	2	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	-	-	2	1,3	-	-	-	14	-	4,7,10,13
	$I_{R\overline{R}}$	1	-	230	-	230	-	230	μAdc	-	-	-	-	-	-	-	-	1	2	-	-	-	14	1	3,4,7,11,13
	$I_{R\overline{S}}$	4	-	140	-	140	-	140	μAdc	-	-	-	-	-	-	-	-	4	3	-	-	-	14	4	1,2,7,10,13
	$I_{R\overline{C}}$	13	-	290	-	290	-	290	μAdc	-	-	-	-	-	-	-	-	13	-	-	-	-	14	-	1,2,3,4,7,10,11,12
Breakdown Voltage	BV_{in}	3	-	-	5.5	-	-	-	Vdc	-	-	3	-	-	-	-	-	-	2,4	-	-	-	14	-	1,7,10,13
		2	-	-	↓	-	-	-	↓	-	-	2	-	-	-	-	-	-	1,3	-	-	-	↓	-	4,7,10,13
		1	-	-	↓	-	-	-	↓	-	-	-	1	-	-	-	-	-	2	-	-	-	↓	1	3,4,7,11,13
		4	-	-	↓	-	-	-	↓	-	-	-	4	-	-	-	-	-	3	-	-	-	↓	4	1,2,7,10,13
		13	-	-	↓	-	-	-	↓	-	-	-	13	-	-	-	-	-	-	-	-	-	↓	-	1,2,3,4,7,10,11,12
Clamp Voltage	V_D	3	-	-	-	-1.5	-	-	Vdc	-	-	-	-	3	-	-	-	-	-	-	-	14	-	-	7,10
		2	-	-	-	↓	-	-	↓	-	-	-	-	2	-	-	-	-	-	-	-	↓	-	-	↓
		1	-	-	-	↓	-	-	↓	-	-	-	-	1	-	-	-	-	-	-	-	↓	-	-	↓
		4	-	-	-	↓	-	-	↓	-	-	-	-	4	-	-	-	-	-	-	-	↓	-	-	↓
		13	-	-	-	↓	-	-	↓	-	-	-	-	13	-	-	-	-	-	-	-	↓	-	-	↓
Output																									
Output Voltage	V_{OL}	5	-	0.4	-	0.4	-	0.4	Vdc	5	-	-	-	-	1	4	-	-	-	-	-	-	14	1	7,10
		6	-	0.4	-	0.4	-	0.4	Vdc	6	-	-	-	-	4	1	-	-	-	-	-	-	14	4	7,10
	V_{OH}	5	2.5	-	2.5	-	2.5	-	Vdc	-	5	-	-	-	4	1	-	-	-	-	-	14	-	4	7,10
		6	2.5	-	2.5	-	2.5	-	Vdc	-	6	-	-	-	1	4	-	-	-	-	-	14	-	1	7,10
Short-Circuit Current	I_{SC}	5	-	-	-20	-60	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	4,5,7,10
		6	-	-	-20	-60	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1,6,7,10
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	42	-	-	mAdc	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	4,7,10
Power Supply Drain	I_{PD}	14	-	30	-	30	-	30	mAdc	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	1,7

*Momentarily ground pin prior to taking measurement. (If pin is also in another column, the pin must be returned to that voltage or current for measurement.)

OPERATING CHARACTERISTICS

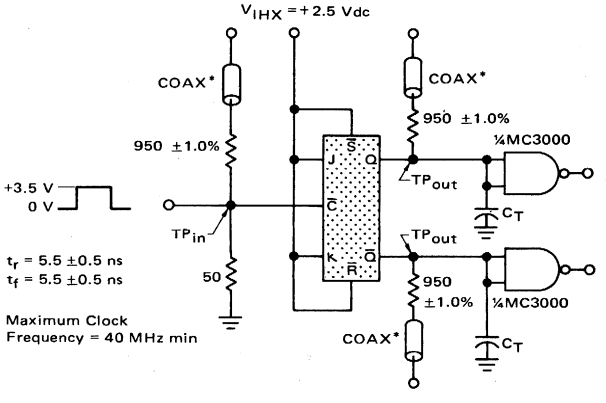
High state data must be present 12 ns prior to the fall of the clock and remain until 0 ns after the clock falls.

The direct $\overline{SET}$ (individual) inputs and $\overline{RESET}$ (common) inputs may be used at any time without regard to the clock state. The flip-flop is set to the Q = 1 state by applying a low level to the $\overline{SET}$ input or reset to the Q = 0 state by applying a low level to the $\overline{RESET}$ input. If these inputs are not used they should be returned to a voltage between 2.0 and 5.5 Vdc.

Negative edge triggering — The input state during the time interval between the Setup and Hold times is stored in the flip-flop when the clock goes low.

Unused clocked inputs should be tied to the clock, to the internally connected output, or to a voltage between 2.0 and 5.5 Vdc.

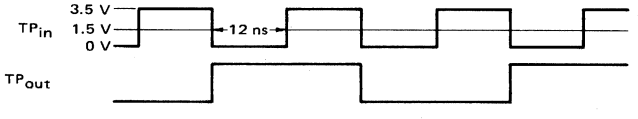
MAXIMUM CLOCK FREQUENCY TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

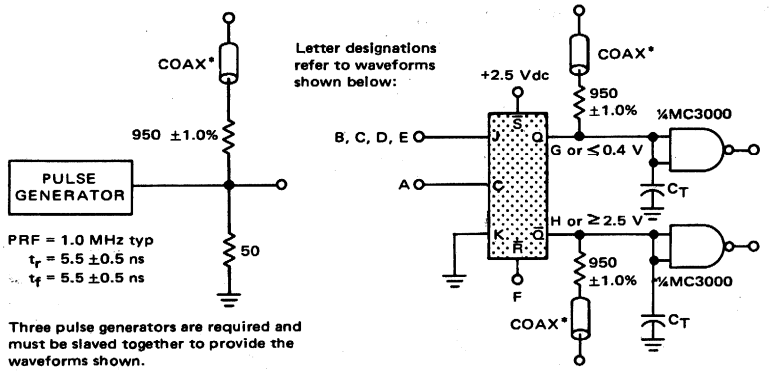
VOLTAGE WAVEFORMS AND DEFINITIONS



OPERATING CHARACTERISTICS (continued)

SWITCHING TIME TEST CIRCUIT

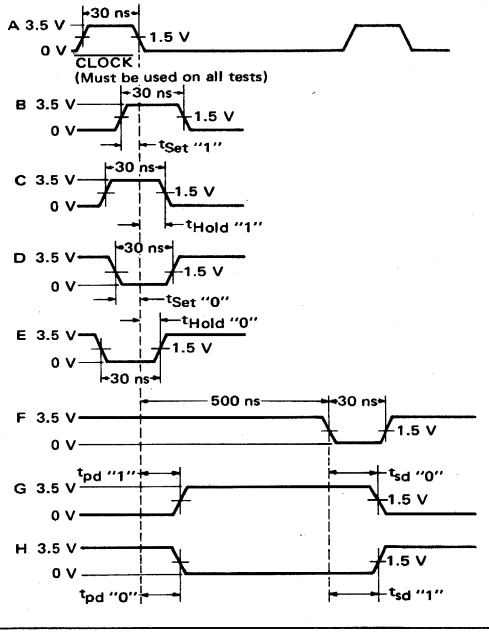
(For J Inputs and $\overline{\text{RESET}}$ Input; to test other inputs, refer to Test Procedures Chart)



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



TEST PROCEDURES CHART

TEST	INPUT J*	INPUT $\overline{\text{SET}}$*	INPUT $\overline{\text{RESET}}$*	INPUT K*	Q*	$\overline{Q}$*	LIMITS (ns) Max
t_{Set} "1" J	B	2.5 V	F	Gnd	G	H	15
t_{Hold} "1" J	C	2.5 V	F	Gnd	G	H	0**
t_{Set} "0" J	D	2.5 V	F	Gnd	≤0.4 V	≥2.5 V	15
t_{Hold} "0" J	E	2.5 V	F	Gnd	≤0.4 V	≥2.5 V	0**
t_{Set} "1" K	Gnd	F	2.5 V	B	H	G	15
t_{Hold} "1" K	Gnd	F	2.5 V	C	H	G	0**
t_{Set} "0" K	Gnd	F	2.5 V	D	≥2.5 V	≤0.4 V	15
t_{Hold} "0" K	Gnd	F	2.5 V	E	≥2.5 V	≤0.4 V	0**
t_{pd} "1"	Delay from clock to Q during t_{Set} "1" J test. Delay from clock to $\overline{Q}$ during t_{Set} "1" K test.						18
t_{pd} "0"	Delay from clock to $\overline{Q}$ during t_{Set} "1" J test. Delay from clock to Q during t_{Set} "1" K test.						18
t_{sd} "1"	Delay from $\overline{\text{SET}}$ to Q during t_{Set} "1" K test. Delay from $\overline{\text{RESET}}$ to $\overline{Q}$ during t_{Set} "1" J test.						18
t_{sd} "0"	Delay from $\overline{\text{SET}}$ to $\overline{Q}$ during t_{Set} "1" K test. Delay from $\overline{\text{RESET}}$ to Q during t_{Set} "1" J test.						18

*Letters shown in these columns refer to waveforms shown at the left.
**t_{Hold} is typically a negative number.

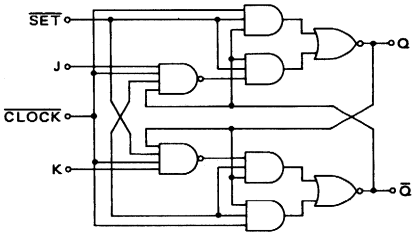
DUAL J-K FLIP-FLOP

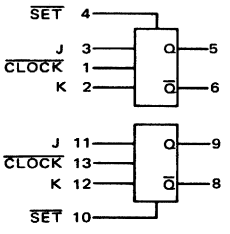
MC3062

The MC3062 dual JK flip-flop triggers on the negative edge of the clock. Each flip-flop is provided with a separate direct $\overline{SET}$ input. These direct inputs provide a means of presetting the flip-flop to initial conditions or other asynchronous operations.

Data may be applied to or changed at, the clocked inputs at any time during the clock cycle, except during the time interval between the Set-up and Hold times. The inputs are inhibited when the clock is low and enabled when the clock rises. The input steering network continuously responds to input information when the clock is high. The data state at the inputs throughout the interval between Set-up and Hold time is stored in the flip-flop when the clock falls. Each flip-flop may be set at anytime without regard to the clock state by applying a low level to the $\overline{SET}$ input.

LOGIC DIAGRAM
1/2 OF DEVICE SHOWN





Input Loading Factors:
$\overline{CLOCK}$, $\overline{SET}$ = 1.6
J, K, = 0.6

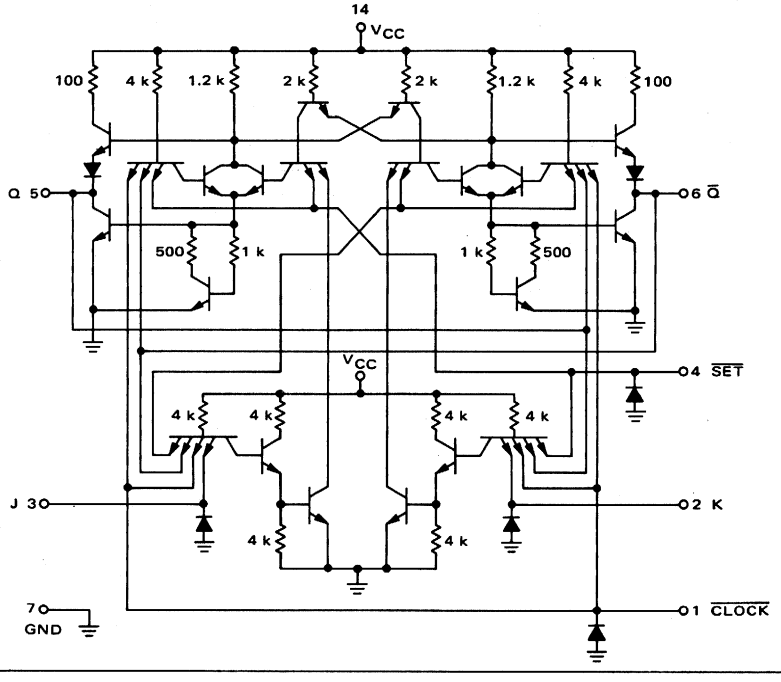
Output Loading Factor = 10

J-K TRUTH TABLE

J	K	Q^n	Q^{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Typical Characteristics:
(V_{CC} = 5.0 V; T_A = 25°C)

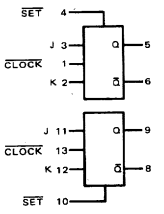
Total Power Dissipation = 100 mW/pkg
Toggle Frequency = 50 MHz
Logical "1" Setup Time = 8.0 ns
Logical "0" Setup Time = 8.0 ns
Logical "1" and "0" Hold Times = 0 ns
t_{pd} "1" = 12 ns
t_{pd} "0" = 12 ns



1/2 OF DEVICE SHOWN

ELECTRICAL CHARACTERISTICS

Test procedures are shown for only one flip-flop. The other flip-flop is tested in the same manner.



@ Test Temperature	TEST CURRENT/VOLTAGE VALUES												
	mA					Volts							
	I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	
0°C	23	-2.0	-	-	-	0.4	2.5	4.0	-	5.0	4.5	5.5	
+25°C	23	-2.0	1.0	2.0	-10	0.4	2.5	4.0	7.0	5.0	4.5	5.5	
+75°C	23	-2.0	-	-	-	0.4	2.5	4.0	-	5.0	4.5	5.5	

Characteristic	Symbol	Pin Under Test	MC3062 Test Limits 0°C Min	0°C Max	+25°C Min	+25°C Max	+75°C Min	+75°C Max	Unit	TEST CURRENT/VOLTAGE APPLIED TO PINS LISTED BELOW: I_{OL}	I_{OH}	I_{in}	$2I_{in}$	I_D	V_F	V_R	V_{RH}	V_{max}	V_{CC}	V_{CCL}	V_{CCH}	P_1*	Gnd
Input																							
Forward Current	I_F	2	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	2	-	1,4	-	-	-	14	-	3,6,7,13
		3	-	-1.5	-	-1.5	-	-1.5	mAdc	-	-	-	-	-	3	-	1,4	-	-	-	14	-	2,5,7,13
	$I_{F\overline{S}}$	4	-	-1.8	-	-1.8	-	-1.8	mAdc	-	-	-	-	-	4	-	1,2	-	-	-	14	-	3,7,13
	$I_{F\overline{C}}$	1	-	-2.9	-	-2.9	-	-2.9	mAdc	-	-	-	-	-	1	-	2,3	-	-	-	14	4	7,13
		1	-	-2.9	-	-2.9	-	-2.9	mAdc	-	-	-	-	-	1	-	2,3,4	-	-	-	14	5	7,13
Leakage Current	I_R	2	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	2	3	-	-	-	14	-	1,4,7,13
		3	-	80	-	80	-	80	μAdc	-	-	-	-	-	-	3	2	-	-	-	14	-	1,4,7,13
	$I_{R\overline{S}}$	4	-	140	-	140	-	140	μAdc	-	-	-	-	-	-	4	3	-	-	-	14	-	1,2,7,13
	$I_{R\overline{C}}$	1	-	170	-	170	-	170	μAdc	-	-	-	-	-	-	1	-	-	-	-	14	-	2,3,4,7,13
Breakdown Voltage	BV_{in}	2	-	-	5.5	-	-	-	Vdc	-	-	2	-	-	-	-	-	-	-	-	14	-	1,4,7,13
		3	-	-	↓	-	-	-	↓	-	-	3	-	-	-	-	-	-	-	-	↓	-	1,4,7,13
		4	-	-		-	-	-		-	-	-	4	-	-	-	-	-	-	-		-	1,2,7,13
		1	-	-		-	-	-		-	-	-	1	-	-	-	-	-	-	-		-	2,3,4,7,13
Clamp Voltage	V_D	2	-	-	-	-1.5	-	-	Vdc	-	-	-	-	2	-	-	-	-	-	14	-	-	7,13
		3	-	-	-	↓	-	-	↓	-	-	-	-	3	-	-	-	-	-	↓	-	-	↓
		4	-	-	-		-	-		-	-	-	-	4	-	-	-	-	-		-	-	
		1	-	-	-		-	-		-	-	-	-	1	-	-	-	-	-		-	-	
Output																							
Output Voltage	V_{OL}	5	-	0.4	-	0.4	-	0.4	Vdc	5	-	-	-	-	-	-	-	-	-	-	14	5	1,7,13
		6	-	0.4	-	0.4	-	0.4	Vdc	6	-	-	-	-	4	-	-	-	-	-	14	4	1,7,13
	V_{OH}	5	2.5	-	2.5	-	2.5	-	Vdc	-	5	-	-	-	4	-	-	-	-	14	-	4	7
		6	2.5	-	2.5	-	2.5	-	Vdc	-	6	-	-	-	-	-	4	-	-	14	-	5	1,7,13
Short-Circuit Current	I_{SC}	5	-	-	-20	-60	-	-	mAdc	-	-	-	-	-	-	-	-	-	14	-	-	-	4,5,7,13
Power Requirements (Total Device) Maximum Power Supply Current	I_{max}	14	-	-	-	41	-	-	mAdc	-	-	-	-	-	-	-	-	14	-	-	-	-	4,7,10
Power Supply Drain	I_{PD}	14	-	29	-	29	-	29	mAdc	-	-	-	-	-	-	-	-	-	14	-	-	-	4,7,10

* Momentarily ground pin prior to taking measurement. (If pin is also in another column the pin must be returned to that voltage or current for measurement.)

OPERATING CHARACTERISTICS

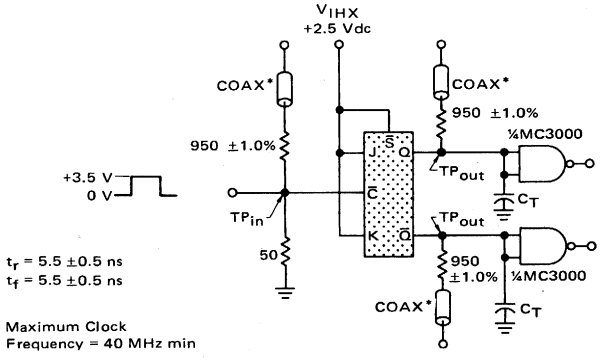
The data must be present 12 ns prior to the fall of the clock and remain until 0 ns after the clock falls.

The flip-flop is set to the Q = 1 state by applying a low level to the $\overline{SET}$ input. The direct $\overline{SET}$ inputs may be used at any time without regard to the clock state. If these inputs are not used they should be returned to a voltage between 2.0 and 5.5 Vdc.

Negative edge triggering – The input state during the time interval between the Setup and Hold times is stored in the flip-flop when the clock goes low.

Unused clocked inputs should be tied to the clock, to the internally connected output, or to a voltage between 2.0 and 5.5 Vdc.

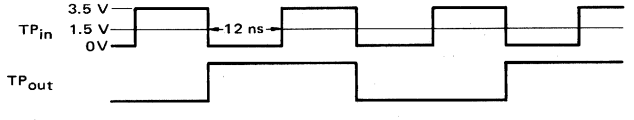
MAXIMUM CLOCK FREQUENCY TEST CIRCUIT



*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

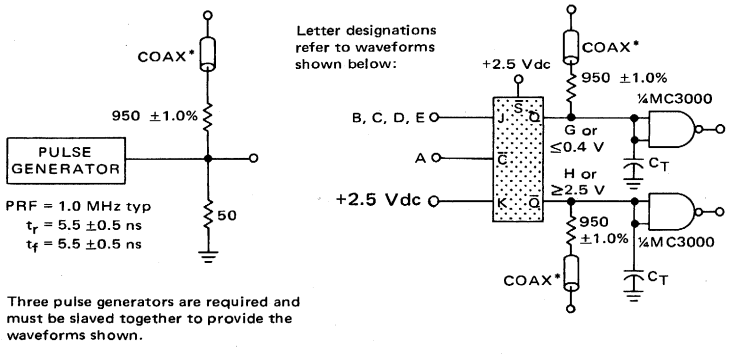
VOLTAGE WAVEFORMS AND DEFINITIONS



OPERATING CHARACTERISTICS (continued)

SWITCHING TIME TEST CIRCUIT

(For J Inputs; to test other inputs, refer to Test Procedures Chart)

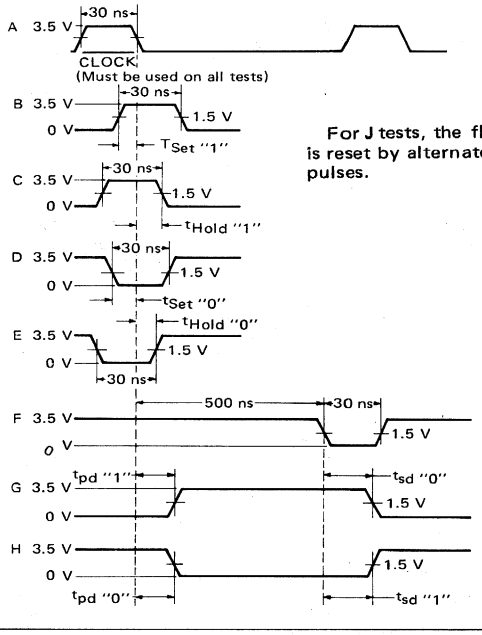


Three pulse generators are required and must be slaved together to provide the waveforms shown.

*The coax delays from input to scope and output to scope must be matched. The scope must be terminated in 50-ohm impedance. The 950-ohm resistor and the scope termination impedance constitute a 20:1 attenuator probe. Coax shall be CT-070-50 or equivalent.

C_T = 25 pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.

VOLTAGE WAVEFORMS AND DEFINITIONS



For J tests, the flip-flop is reset by alternate clock pulses.

TEST PROCEDURES CHART

TEST	INPUT J*	INPUT $\overline{SET}$*	INPUT K*	Q*	$\bar{Q}$*	LIMITS (ns) Max
t_{Set} "1" J	B	2.5 V	2.5 V	G	H	15
t_{Hold} "1" J	C	2.5 V	2.5 V	G	H	0**
t_{Set} "0" J	D	2.5 V	2.5 V	≤0.4 V	≥2.5 V	15
t_{Hold} "0" J	E	2.5 V	2.5 V	≤0.4 V	≥2.5 V	0**
t_{Set} "1" K	Gnd	F	B	H	G	15
t_{Hold} "1" K	Gnd	F	C	H	G	0**
t_{Set} "0" K	Gnd	F	D	≥2.5 V	≤0.4 V	15
t_{Hold} "0" K	Gnd	F	E	≥2.5 V	≤0.4 V	0**
t_{pd} "1"	Delay from $\overline{clock}$ to Q during t_{Set} "1" J test. Delay from $\overline{clock}$ to $\bar{Q}$ during t_{Set} "1" K test.					18
t_{pd} "0"	Delay from $\overline{clock}$ to $\bar{Q}$ during t_{Set} "1" J test. Delay from $\overline{clock}$ to Q during t_{Set} "1" K test.					18
t_{sd} "1"	Delay from $\overline{SET}$ to Q during t_{Set} "1" K test.					18
t_{sd} "0"	Delay from $\overline{SET}$ to $\bar{Q}$ during t_{Set} "1" K test.					18

*Letters shown in test columns refer to waveforms shown at the left.
**t_{Hold} is typically a negative number.