# MC14009AL
# MC14009CL
# MC14009CP
# MC14010AL
# MC14010CL
# MC14010CP

## HEX BUFFERS

The MC14009 hex inverter/buffer and MC14010 noninverting hex buffer are constructed with MOS P-channel and N-channel enhancement mode devices in a single monolithic structure. These complementary MOS devices find primary use where low power dissipation and/or high noise immunity is desired. Both devices can be used as current "sink" or "source" drivers, as CMOS-to-CMOS or CMOS-to-bipolar (TTL or DTL) logic level converters, or as multiplexers (1-to-6). The MC14009 also provides the invert function.

- Quiescent Power Dissipation = 50 nW/package typical
- High Current Sinking Capability
  8.0 mA minimum @ $V_{OL}$ = 0.5 V and $V_{DD}$ = 10 V
- Supply Voltage Range = 3.0 Vdc to 18 Vdc (MC14009/10 AL)
  3.0 Vdc to 16 Vdc (MC14009/10CL/CP)
- Wide CMOS-to-Bipolar Conversion Range –
  From MCMOS operating with specified supply voltage range to TTL or DTL operating with +3.0 V to +6.0 V supply. Conversion with logic output levels > 6.0 V is permitted if $V_{CC} \leq V_{DD}$.
- Pin for Pin Replacement for CD4009A – MC14009
  CD4010A – MC14010

**McMOS**

(LOW-POWER COMPLEMENTARY MOS)

**HEX BUFFERS**

**Inverting – MC14009AL/CL/CP**
**Noninverting – MC14010AL/CL/CP**


**L SUFFIX**
**CERAMIC PACKAGE**
**CASE 620**

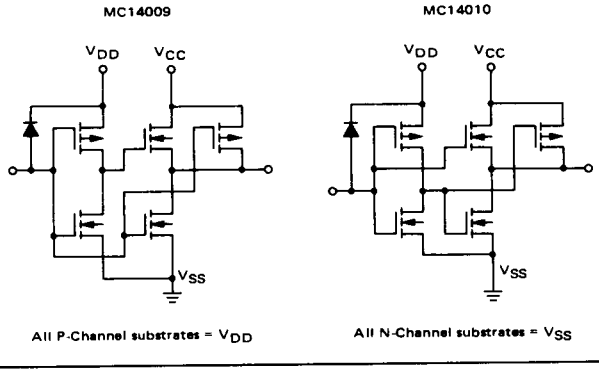

**P SUFFIX**
**PLASTIC PACKAGE**
**CASE 648**

**MAXIMUM RATINGS** (Voltages referenced to $V_{SS}$, Pin 8)

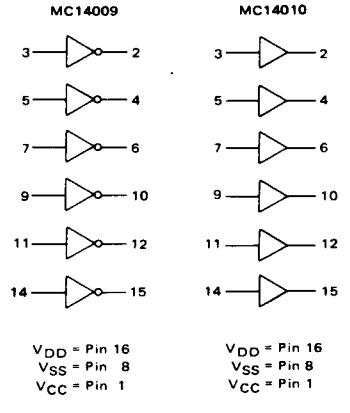
| Rating | Symbol | Value | Unit |
|---|---|---|---|
| DC Supply Voltage ($V_{CC} \leq V_{DD}$) –AL Version | $V_{DD}$ | +18 to –0.5 | Vdc |
| CL,CP Version | | +16 to –0.5 | |
| Input Voltage, All Inputs | $V_{in}$ | $V_{DD}$ to –0.5 | Vdc |
| DC Current Drain per Pin* | I | 10 | mAdc |
| Operating Temperature Range –AL Version | $T_A$ | –55 to +125 | °C |
| CL,CP Version | | –40 to +85 | |
| Storage Temperature Range | $T_{stg}$ | –65 to +150 | °C |

*Buffered Outputs may supply higher current.

**CIRCUIT SCHEMATIC**
(1/6 OF CIRCUIT SHOWN)




**LOGIC DIAGRAMS**




See Mechanical Data Section for package dimensions.

**ELECTRICAL CHARACTERISTICS**

| Characteristic | Figure | Symbol | $V_{DD}$ Vdc | $V_{CC}$ Vdc | MC14009/10AL -55°C Min | MC14009/10AL -55°C Max | MC14009/10AL +25°C Min | MC14009/10AL +25°C Typ | MC14009/10AL +25°C Max | MC14009/10AL +125°C Min | MC14009/10AL +125°C Max | MC14009/10CL/CP -40°C Min | MC14009/10CL/CP -40°C Max | MC14009/10CL/CP +25°C Min | MC14009/10CL/CP +25°C Typ | MC14009/10CL/CP +25°C Max | MC14009/10CL/CP +85°C Min | MC14009/10CL/CP +85°C Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Output Voltage | 1,2,3 | $V_{out}$ | | | | | | | | | | | | | | | | | Vdc |
| MC14009 | | | | | | | | | | | | | | | | | | | |
| ($V_{in}$ = 5.0 Vdc) | | | 5.0 | 5.0 | – | 0.01 | – | 0 | 0.01 | – | 0.05 | – | 0.01 | – | 0 | 0.01 | – | 0.05 | |
| ($V_{in}$ = 10 Vdc) | | | 10 | 10 | – | 0.01 | – | 0 | 0.01 | – | 0.05 | – | 0.01 | – | 0 | 0.01 | – | 0.05 | |
| ($V_{in}$ = 15 Vdc) | | | 15 | – | – | – | – | 0 | – | – | – | – | – | – | 0 | – | – | – | |
| MC14010 "0" Level | | | | | | | | | | | | | | | | | | | |
| ($V_{in}$ = 0 Vdc) | | | 5.0 | 5.0 | – | 0.01 | – | 0 | 0.01 | – | 0.05 | – | 0.01 | – | 0 | 0.01 | – | 0.05 | |
| ($V_{in}$ = 0 Vdc) | | | 10 | 10 | – | 0.01 | – | 0 | 0.01 | – | 0.05 | – | 0.01 | – | 0 | 0.01 | – | 0.05 | |
| ($V_{in}$ = 0 Vdc) | | | 15 | – | – | – | – | 0 | – | – | – | – | – | – | 0 | – | – | – | |
| MC14009 | | | | | | | | | | | | | | | | | | | Vdc |
| ($V_{in}$ = 0 Vdc) | | | 5.0 | 5.0 | 4.99 | – | 4.99 | 5.0 | – | 4.95 | – | 4.99 | – | 4.99 | 5.0 | – | 4.95 | – | |
| ($V_{in}$ = 0 Vdc) | | | 10 | 10 | 9.99 | – | 9.99 | 10 | – | 9.95 | – | 9.99 | – | 9.99 | 10 | – | 9.95 | – | |
| ($V_{in}$ = 0 Vdc) | | | 15 | – | – | – | – | 15 | – | – | – | – | – | – | 15 | – | – | – | |
| MC14010 "1" Level | | | | | | | | | | | | | | | | | | | |
| ($V_{in}$ = 5.0 Vdc) | | | 5.0 | 5.0 | 4.99 | – | 4.99 | 5.0 | – | 4.95 | – | 4.99 | – | 4.99 | 5.0 | – | 4.95 | – | |
| ($V_{in}$ = 10 Vdc) | | | 10 | 10 | 9.99 | – | 9.99 | 10 | – | 9.95 | – | 9.99 | – | 9.99 | 10 | – | 9.95 | – | |
| ($V_{in}$ = 15 Vdc) | | | 15 | – | – | – | – | 15 | – | – | – | – | – | – | 15 | – | – | – | |
| Noise Immunity* | – | $V_{NL}$ | | | | | | | | | | | | | | | | | Vdc |
| MC14009 | | | | | | | | | | | | | | | | | | | |
| ($V_{out}$ ≥3.5 Vdc) | | | 5.0 | 5.0 | 1.0 | – | 1.0 | 2.0 | – | 0.9 | – | 1.0 | – | 1.0 | 2.0 | – | 0.9 | – | |
| ($V_{out}$ ≥7.0 Vdc) | | | 10 | 10 | 2.0 | – | 2.0 | 3.0 | – | 1.2 | – | 2.0 | – | 2.0 | 3.0 | – | 1.9 | – | |
| ($V_{out}$ ≥10.5 Vdc) | | | 15 | 15 | – | – | – | 4.5 | – | – | – | – | – | – | 4.5 | – | – | – | |
| ($V_{out}$ ≤1.5 Vdc) | | $V_{NH}$ | 5.0 | 5.0 | 1.4 | – | 1.5 | 2.25 | – | 1.5 | – | 1.4 | – | 1.5 | 2.25 | – | 1.5 | – | Vdc |
| ($V_{out}$ ≤3.0 Vdc) | | | 10 | 10 | 2.9 | – | 3.0 | 4.5 | – | 3.0 | – | 2.9 | – | 3.0 | 4.5 | – | 3.0 | – | |
| ($V_{out}$ ≤4.5 Vdc) | | | 15 | 15 | – | – | – | 6.75 | – | – | – | – | – | – | 6.75 | – | – | – | |
| MC14010 | | $V_{NL}$ | | | | | | | | | | | | | | | | | Vdc |
| ($V_{out}$ ≤1.5 Vdc) | | | 5.0 | 5.0 | 1.5 | – | 1.5 | 2.25 | – | 1.4 | – | 1.5 | – | 1.5 | 2.25 | – | 1.4 | – | |
| ($V_{out}$ ≤3.0 Vdc) | | | 10 | 10 | 3.0 | – | 3.0 | 4.5 | – | 2.9 | – | 3.0 | – | 3.0 | 4.5 | – | 2.9 | – | |
| ($V_{out}$ ≤4.5 Vdc) | | | 15 | 15 | – | – | – | 6.75 | – | – | – | – | – | – | 6.75 | – | – | – | |
| ($V_{out}$ ≥3.5 Vdc) | | $V_{NH}$ | 5.0 | 5.0 | 1.4 | – | 1.5 | 2.25 | – | 1.5 | – | 1.4 | – | 1.5 | 2.25 | – | 1.5 | – | Vdc |
| ($V_{out}$ ≥7.0 Vdc) | | | 10 | 10 | 2.9 | – | 3.0 | 4.5 | – | 3.0 | – | 2.9 | – | 3.0 | 4.5 | – | 3.0 | – | |
| ($V_{out}$ ≥10.5 Vdc) | | | 15 | 15 | – | – | – | 6.75 | – | – | – | – | – | – | 6.75 | – | – | – | |
| Output Drive Current | | | | | | | | | | | | | | | | | | | |
| ($V_{OH}$ = 2.5 Vdc) Source | 5 | $I_{OH}$ | 5.0 | 5.0 | -1.85 | – | -1.25 | -1.75 | – | -0.9 | – | -1.5 | – | -1.25 | -1.75 | – | -1.0 | – | mAdc |
| ($V_{OH}$ = 9.5 Vdc) | | | 10 | 10 | -0.9 | – | -0.6 | -0.8 | – | -0.4 | – | -0.72 | – | -0.6 | -0.8 | – | -0.48 | – | |
| ($V_{OH}$ = 13.5 Vdc) | | | 15 | 15 | – | – | – | -5.0 | – | – | – | – | – | – | -5.0 | – | – | – | |
| ($V_{OL}$ = 0.4 Vdc) Sink | 6 | $I_{OL}$ | 5.0 | 5.0 | 3.75 | – | 3.0 | 4.0 | – | 2.1 | – | 3.6 | – | 3.0 | 4.0 | – | 2.4 | – | mAdc |
| ($V_{OL}$ = 0.5 Vdc) | | | 10 | 10 | 10 | – | 8.0 | 10 | – | 5.6 | – | 9.6 | – | 8.0 | 10 | – | 6.4 | – | |
| ($V_{OL}$ = 1.5 Vdc) | | | 15 | 15 | – | – | – | 35 | – | – | – | – | – | – | 35 | – | – | – | |
| Input Current | – | $I_{in}$ | – | – | – | – | – | 10 | – | – | – | – | – | – | 10 | – | – | – | pAdc |
| Input Capacitance MC14009 | – | $C_{in}$ | – | – | – | – | – | 10 | – | – | – | – | – | – | 10 | – | – | – | pF |
| ($V_{in}$ = 0) MC14010 | | | – | – | – | – | – | 5.0 | – | – | – | – | – | – | 5.0 | – | – | – | |
| Quiescent Dissipation | 7 | $P_D$ | 5.0 | – | – | 1.5 | – | 0.05 | 1.5 | – | 100 | – | 15 | – | 0.15 | 15 | – | 210 | μW |
| | | | 10 | – | – | 5.0 | – | 0.1 | 5.0 | – | 300 | – | 50 | – | 0.5 | 50 | – | 700 | |
| | | | 15 | – | – | – | – | 0.15 | – | – | – | – | – | – | 0.85 | – | – | – | |
| Turn-On Delay Time** | 4 | $t_{PHL}$ | | | | | | | | | | | | | | | | | ns |
| ($C_L$ = 15 pF) | | | | | | | | | | | | | | | | | | | |
| MC14009 | | | | | | | | | | | | | | | | | | | |
| $t_{PHL}$ = (0.16 ns/pF) $C_L$ + 12 ns | | | 5.0 | 5.0 | – | – | – | 15 | 55 | – | – | – | – | – | 15 | 70 | – | – | |
| $t_{PHL}$ = (0.10 ns/pF) $C_L$ + 8.0 ns | | | 10 | 10 | – | – | – | 9.0 | 30 | – | – | – | – | – | 9.0 | 40 | – | – | |
| $t_{PHL}$ = (0.08 ns/pF) $C_L$ + 6.0 ns | | | 15 | 15 | – | – | – | 7.0 | – | – | – | – | – | – | 7.0 | – | – | – | |
| $t_{PHL}$ = (0.05 ns/pF) $C_L$ + 7.0 ns | | | 10 | 5.0 | – | – | – | 8.0 | 25 | – | – | – | – | – | 8.0 | 35 | – | – | |
| $t_{PHL}$ = (0.03 ns/pF) $C_L$ + 5.0 ns | | | 15 | 5.0 | – | – | – | 5.0 | * | – | – | – | – | – | 5.0 | – | – | – | |
| MC14010 | | | | | | | | | | | | | | | | | | | |
| $t_{PHL}$ = (0.38 ns/pF) $C_L$ + 19 ns | | | 5.0 | 5.0 | – | – | – | 25 | 55 | – | – | – | – | – | 25 | 70 | – | – | |
| $t_{PHL}$ = (0.08 ns/pF) $C_L$ + 19 ns | | | 10 | 10 | – | – | – | 20 | 30 | – | – | – | – | – | 20 | 40 | – | – | |
| $t_{PHL}$ = (0.06 ns/pF) $C_L$ + 14 ns | | | 15 | 15 | – | – | – | 15 | – | – | – | – | – | – | 15 | – | – | – | |
| $t_{PHL}$ = (0.08 ns/pF) $C_L$ + 14 ns | | | 10 | 5.0 | – | – | – | 15 | 25 | – | – | – | – | – | 15 | 35 | – | – | |
| $t_{PHL}$ = (0.09 ns/pF) $C_L$ + 9.0 ns | | | 15 | 5.0 | – | – | – | 10 | – | – | – | – | – | – | 10 | – | – | – | |
| Turn-Off Delay Time** | 4 | $t_{PLH}$ | | | | | | | | | | | | | | | | | ns |
| ($C_L$ = 15 pF) | | | | | | | | | | | | | | | | | | | |
| MC14009/10 | | | | | | | | | | | | | | | | | | | |
| $t_{PLH}$ = (1.0 ns/pF) $C_L$ + 35 ns | | | 5.0 | 5.0 | – | – | – | 50 | 80 | – | – | – | – | – | 50 | 100 | – | – | |
| $t_{PLH}$ = (0.40 ns/pF) $C_L$ + 19 ns | | | 10 | 10 | – | – | – | 25 | 55 | – | – | – | – | – | 25 | 70 | – | – | |
| $t_{PLH}$ = (0.34 ns/pF) $C_L$ + 15 ns | | | 15 | 15 | – | – | – | 20 | – | – | – | – | – | – | 20 | – | – | – | |
| $t_{PLH}$ = (0.36 ns/pF) $C_L$ + 20 ns | | | 10 | 5.0 | – | – | – | 25 | 30 | – | – | – | – | – | 25 | 40 | – | – | |
| $t_{PLH}$ = (0.16 ns/pF) $C_L$ + 18 ns | | | 15 | 5.0 | – | – | – | 20 | – | – | – | – | – | – | 20 | – | – | – | |
| Output Rise Time** | 4 | $t_r$ | | | | | | | | | | | | | | | | | ns |
| ($C_L$ = 15 pF) | | | | | | | | | | | | | | | | | | | |
| MC14009 | | | | | | | | | | | | | | | | | | | |
| $t_r$ = (2.4 ns/pF) $C_L$ + 44 ns | | | 5.0 | 5.0 | – | – | – | 80 | 125 | – | – | – | – | – | 80 | 160 | – | – | |
| $t_r$ = (1.0 ns/pF) $C_L$ + 20 ns | | | 10 | 10 | – | – | – | 35 | 100 | – | – | – | – | – | 35 | 120 | – | – | |
| $t_r$ = (0.62 ns/pF) $C_L$ + 20 ns | | | 15 | 15 | – | – | – | 30 | – | – | – | – | – | – | 30 | – | – | – | |
| MC14010 | | | | | | | | | | | | | | | | | | | |
| $t_r$ = (1.6 ns/pF) $C_L$ + 56 ns | | | 5.0 | 5.0 | – | – | – | 80 | 125 | – | – | – | – | – | 80 | 160 | – | – | |
| $t_r$ = (0.76 ns/pF) $C_L$ + 39 ns | | | 10 | 10 | – | – | – | 50 | 100 | – | – | – | – | – | 50 | 120 | – | – | |
| $t_r$ = (0.6 ns/pF) $C_L$ + 21 ns | | | 15 | 15 | – | – | – | 30 | – | – | – | – | – | – | 30 | – | – | – | |
| Output Fall Time ** | 4 | $t_f$ | | | | | | | | | | | | | | | | | ns |
| ($C_L$ = 15 pF) | | | | | | | | | | | | | | | | | | | |
| MC14009 | | | | | | | | | | | | | | | | | | | |
| $t_f$ = (0.22 ns/pF) $C_L$ + 9.0 ns | | | 5.0 | 5.0 | – | – | – | 13 | 45 | – | – | – | – | – | 13 | 60 | – | – | |
| $t_f$ = (0.10 ns/pF) $C_L$ + 7.0 ns | | | 10 | 10 | – | – | – | 9.0 | 40 | – | – | – | – | – | 9.0 | 50 | – | – | |
| $t_f$ = (0.07 ns/pF) $C_L$ + 6.0 ns | | | 15 | 15 | – | – | – | 7.0 | – | – | – | – | – | – | 7.0 | – | – | – | |
| MC14010 | | | | | | | | | | | | | | | | | | | |
| $t_f$ = (0.20 ns/pF) $C_L$ + 22 ns | | | 5.0 | 5.0 | – | – | – | 25 | 45 | – | – | – | – | – | 25 | 60 | – | – | |
| $t_f$ = (0.07 ns/pF) $C_L$ + 15 ns | | | 10 | 10 | – | – | – | 16 | 40 | – | – | – | – | – | 16 | 50 | – | – | |
| $t_f$ = (0.07 ns/pF) $C_L$ + 9.0 ns | | | 15 | 15 | – | – | – | 10 | – | – | – | – | – | – | 10 | – | – | – | |

*DC Noise Margin ($V_{NH}$, $V_{NL}$) is defined as the maximum voltage change, from an ideal "1" or "0" input level, before producing an output state change.
**The formula given is for the typical characteristics only.

FIGURE 1 – CURRENT AND VOLTAGE TRANSFER CHARACTERISTICS TEST CIRCUIT

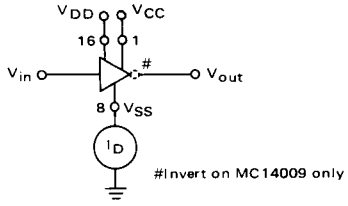



FIGURE 2 – TYPICAL VOLTAGE AND CURRENT TRANSFER CHARACTERISTICS versus TEMPERATURE

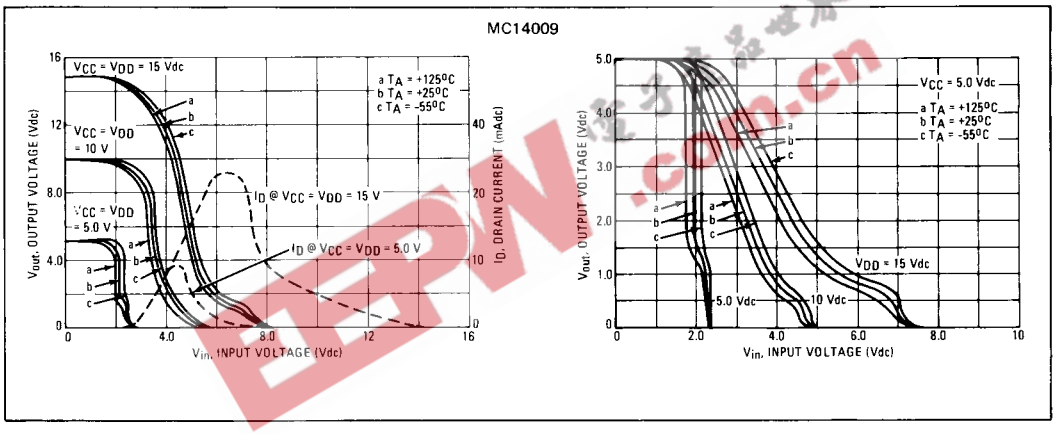



FIGURE 3 – TYPICAL VOLTAGE TRANSFER CHARACTERISTICS versus TEMPERATURE

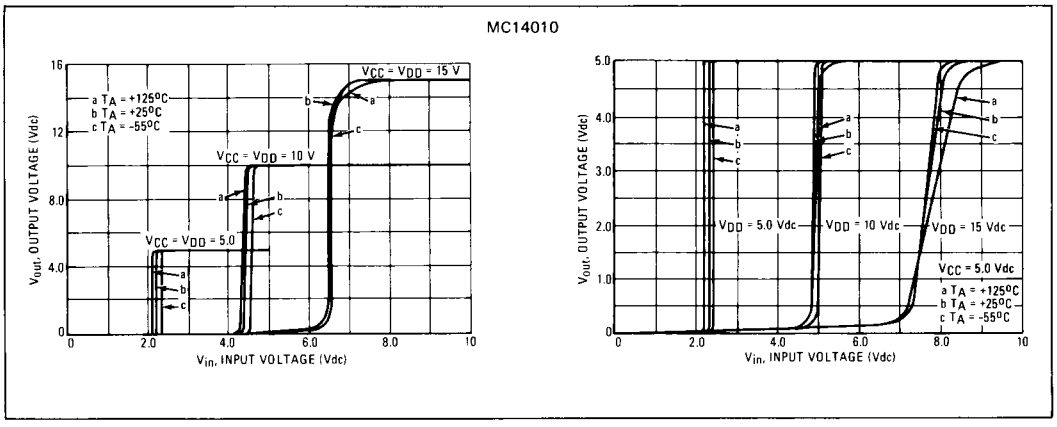


FIGURE 4 – SWITCHING TIME TEST CIRCUIT AND WAVEFORMS

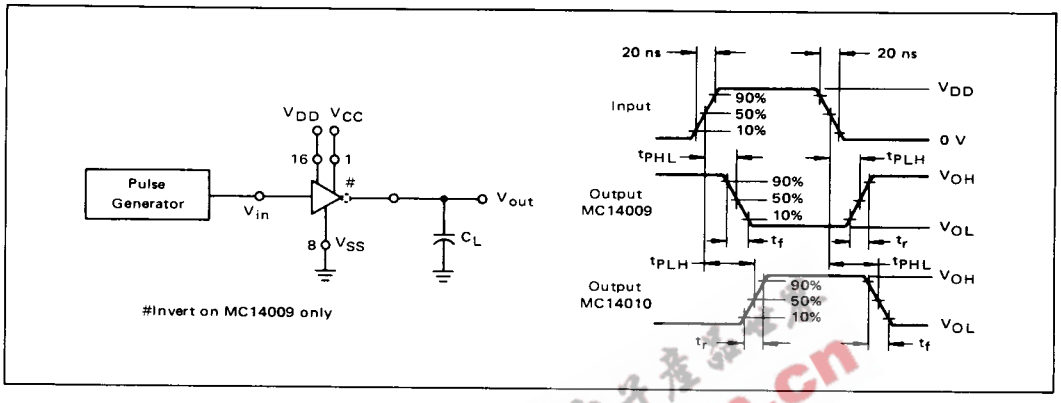
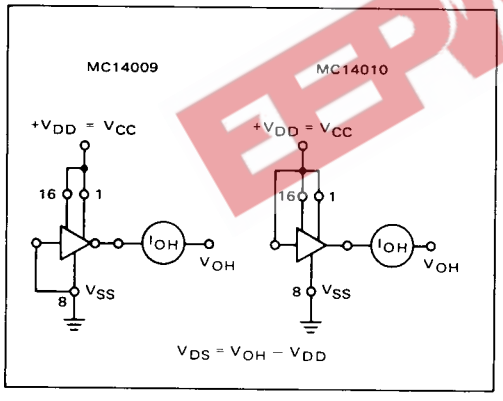



FIGURE 5 – TYPICAL OUTPUT SOURCE CHARACTERISTICS



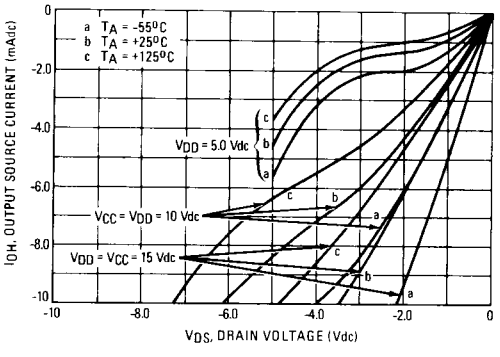
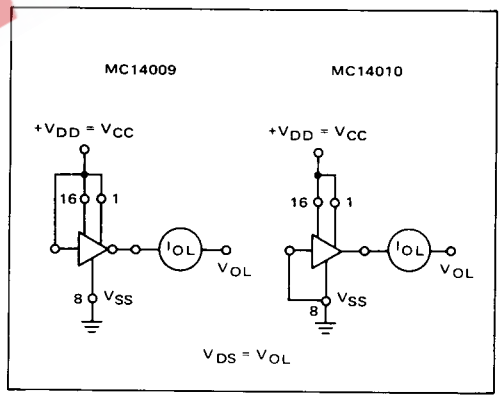




FIGURE 6 – TYPICAL OUTPUT SINK CHARACTERISTICS



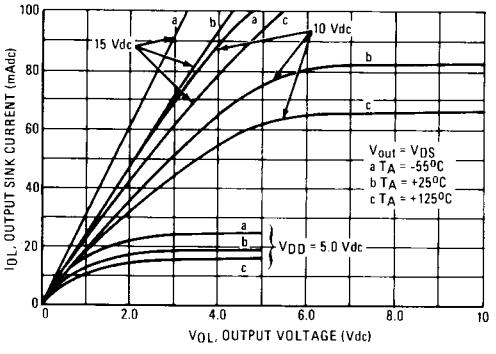






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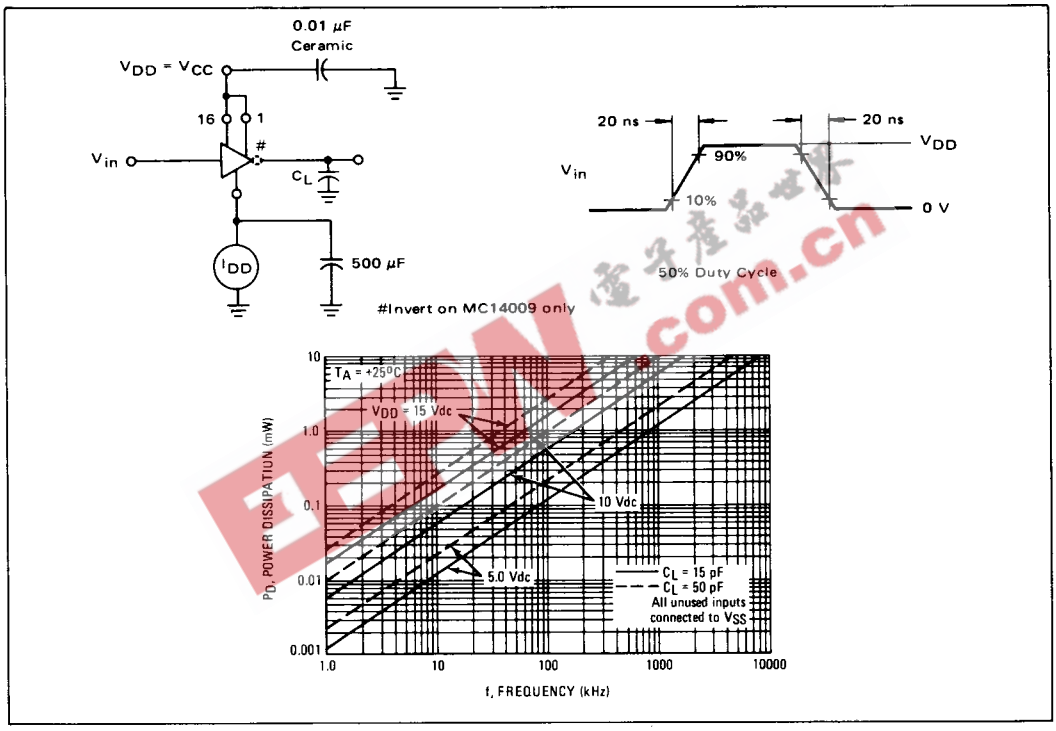
FIGURE 7 – TYPICAL DYNAMIC POWER DISSIPATION CHARACTERISTICS




This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that $V_{in}$ and $V_{out}$ be constrained to the range $V_{SS} \leq (V_{in}$ or $V_{out}) \leq V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either $V_{SS}$ or $V_{DD}$)