FAIRCHILD SEMICONDUCTOR™

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# MM74C908
# Dual CMOS 30-Volt Relay Driver

## General Description

The MM74C908 is a general purpose dual high voltage driver capable of sourcing a minimum of 250 mA at $V_{OUT} = V_{CC} - 3V$, and $T_J = 65°C$.

The MM74C908 consists of two CMOS NAND gates driving an emitter follower Darlington output to achieve high current drive and high voltage capabilities. In the "OFF" state the outputs can withstand a maximum of –30V across the device. These CMOS drivers are useful in interfacing normal CMOS voltage levels to driving relays, regulators, lamps, etc.

## Features

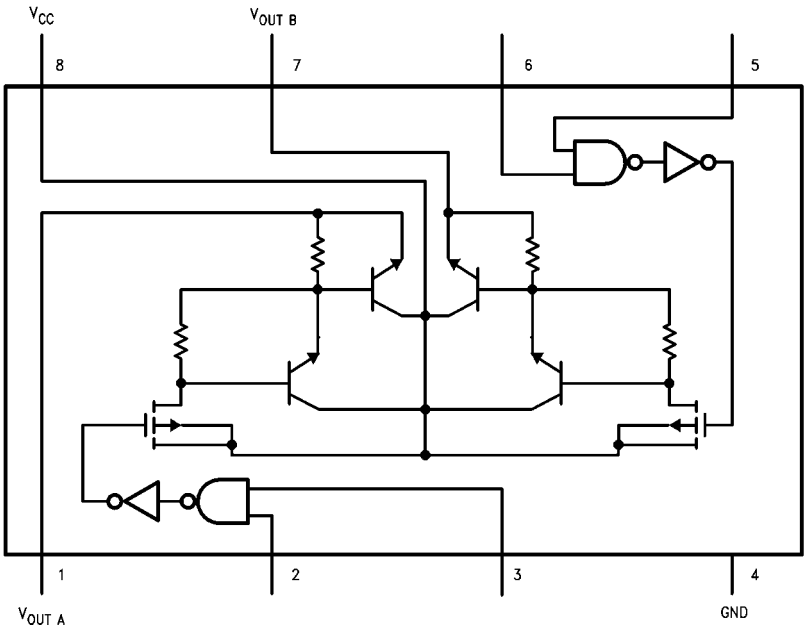
- Wide supply voltage range: 3V to 18V
- High noise immunity: 0.45 $V_{CC}$ (typ.)
- Low output "ON" resistance: 8Ω (typ.)
- High voltage: –30V
- High current: 250 mA

## Ordering Code:

| Order Number | Package Number | Package Description |
|---|---|---|
| MM74C908N | N08E | 8-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide |

## Connection Diagram

**Pin Assignments for DIP**




**Top View**

## Absolute Maximum Ratings (Note 1)

| | |
|---|---|
| Voltage at any Input Pin | −0.3V to $V_{CC}$ +0.3V |
| Voltage at any Output Pin | 32V |
| Operating Temperature Range | −40°C to +85°C |
| Operating $V_{CC}$ Range | 4V to 18V |
| Absolute Maximum $V_{CC}$ | 19V |
| $I_{SOURCE}$ | 500 mA |
| Storage Temperature Range ($T_S$) | −65°C to +150°C |
| Lead Temperature ($T_L$) (Soldering, 10 seconds) | 260°C |
| Power Dissipation ($P_D$) | Refer to Maximum Power Dissipation vs Ambient Temperature Graph |

**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The Electrical Characteristics table provides conditions for actual device operation.

## DC Electrical Characteristics

Min/Max limits apply across temperature range, unless otherwise noted

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **CMOS TO CMOS** | | | | | | |
| $V_{IN(1)}$ | Logical "1" Input Voltage | $V_{CC}$ = 5V | 3.5 | | | V |
| | | $V_{CC}$ = 10V | 8.0 | | | V |
| $V_{IN(0)}$ | Logical "0" Input Voltage | $V_{CC}$ = 5V | | | 1.5 | V |
| | | $V_{CC}$ = 10V | | | 2.0 | V |
| $I_{IN(1)}$ | Logical "1" Input Current | $V_{CC}$ = 15V, $V_{IN}$ = 15V | | 0.005 | 1.0 | µA |
| $I_{IN(0)}$ | Logical "0" Input Current | $V_{CC}$ = 15V, $V_{IN}$ = 0V | −1.0 | −0.005 | | µA |
| $I_{CC}$ | Supply Current | $V_{CC}$ = 15V, Outputs Open Circuit | | 0.05 | 15 | µA |
| | Output "OFF" Voltage | $V_{IN}$ = $V_{CC}$, $I_{OUT}$ = −200 µA | | −30 | | V |
| **CMOS/LPTTL INTERFACE** | | | | | | |
| $V_{IN(1)}$ | Logical "1" Input Voltage | $V_{CC}$ = 4.75V | $V_{CC}$ − 1.5 | | | V |
| $V_{IN(0)}$ | Logical "0" Input Voltage | $V_{CC}$ = 4.75V | | | 0.8 | V |
| **OUTPUT DRIVE** | | | | | | |
| $V_{OUT}$ | Output Voltage | $I_{OUT}$ = −300 mA, $V_{CC}$ ≥ 5V, $T_J$ = 25°C | $V_{CC}$−2.7 | $V_{CC}$−1.8 | | V |
| | | $I_{OUT}$ = −250 mA, $V_{CC}$ ≥ 5V, $T_J$ = 65°C | $V_{CC}$−3.0 | $V_{CC}$−1.9 | | V |
| | | $I_{OUT}$ = −175 mA, $V_{CC}$ ≥ 5V, $T_J$ = 150°C | $V_{CC}$−3.15 | $V_{CC}$−2.0 | | V |
| $R_{ON}$ | Output Resistance | $I_{OUT}$ = −300 mA, $V_{CC}$ ≥ 5V, $T_J$ = 25°C | | 6.0 | 9.0 | Ω |
| | | $I_{OUT}$ = −250 mA, $V_{CC}$ ≥ 5V, $T_J$ = 65°C | | 7.5 | 12 | Ω |
| | | $I_{OUT}$ = −175 mA, $V_{CC}$ ≥ 5V, $T_J$ = 150°C | | 10 | 18 | Ω |
| | Output Resistance Coefficient | | | 0.55 | 0.80 | %/°C |
| $\theta_{JA}$ | Thermal Resistance | (Note 2) | | 100 | 110 | °C/W |
| | MM74C908 | (Note 2) | | 45 | 55 | °C/W |

**Note 2:** $\theta_{JA}$ measured in free air with device soldered into printed circuit board.

## AC Electrical Characteristics (Note 3)

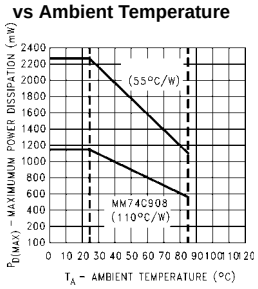
| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $t_{pd1}$ | Propagation Delay to a Logical "1" | $V_{CC}$ = 5V, $R_L$ = 50Ω, $C_L$ = 50 pF, $T_A$ = 25°C | | 150 | 300 | ns |
| | | $V_{CC}$ = 10V, $R_L$ = 50Ω, $C_L$ = 50 pF, $T_A$ = 25°C | | 65 | 120 | ns |
| $t_{pd0}$ | Propagation Delay to a Logic "0" | $V_{CC}$ = 5V, $R_L$ = 50Ω, $C_L$ = 50 pF, $T_A$ = 25°C | | 2.0 | 10 | µs |
| | | $V_{CC}$ = 10V, $R_L$ = 50Ω, $C_L$ = 50 pF, $T_A$ = 25°C | | 4.0 | 20 | µs |
| $C_{IN}$ | Input Capacitance | (Note 4) | | 5.0 | | pF |

**Note 3:** AC Parameters are guaranteed by DC correlated testing.

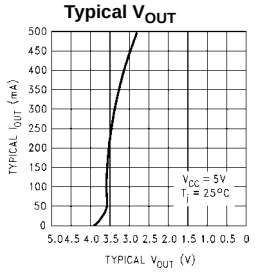
**Note 4:** Capacitance is guaranteed by periodic testing.

## Typical Performance Characteristics

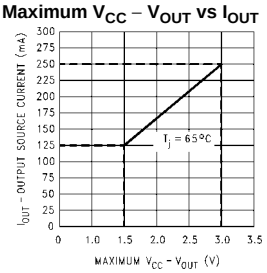
**Maximum Power Dissipation vs Ambient Temperature**



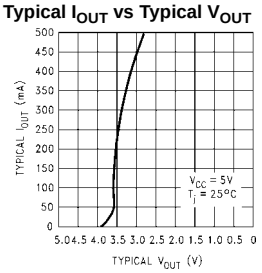

**Typical $I_{OUT}$ vs Typical $V_{OUT}$**



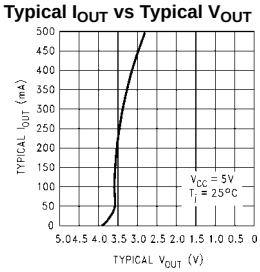

**Maximum $V_{CC} - V_{OUT}$ vs $I_{OUT}$**



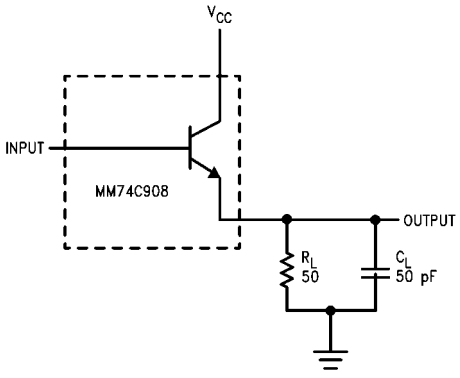

**Typical $I_{OUT}$ vs Typical $V_{OUT}$**



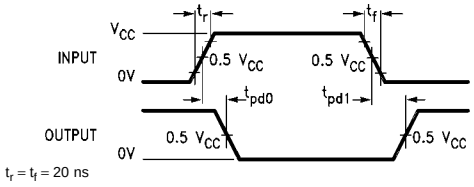

**Typical $I_{OUT}$ vs Typical $V_{OUT}$**




## AC Test Circuit




## Switching Time Waveforms




$t_r = t_f = 20$ ns

## Power Considerations

**Calculating Output "ON" Resistance ($R_L$ > 18Ω)**

The output "ON" resistance, $R_{ON}$, is a function of the junction temperature, $T_J$, and is given by:

$$R_{ON} = 9\ (T_J - 25)\ (0.008) + 9: \quad (1)$$

and $T_J$ is given by:

$$T_J = T_A + P_{DAV}\ \theta_{JA},: \quad (2)$$

where $T_A$ = ambient temperature, $\theta_{JA}$ = thermal resistance, and $P_{DAV}$ is the average power dissipated within the device. $P_{DAV}$ consists of normal CMOS power terms (due to leakage currents, internal capacitance, switching, etc.) which are insignificant when compared to the power dissipated in the outputs. Thus, the output power term defines the allowable limits of operation and includes both outputs, A and B. $P_D$ is given by:

$$P_D = I_{OA}^2 R_{ON} + I_{OB}^2\ R_{ON}, \quad (3)$$

where $I_O$ is the output current, given by:

$$I_O = \frac{V_{CC} - V_L}{R_{ON} + R_L} \quad (4)$$

$V_L$ is the load voltage.

The average power dissipation, $P_{DAV}$, is a function of the duty cycle:

$$P_{DAV} = I_{OA}^2 R_{ON}\ (\text{Duty Cycle}_A) + \quad (5)$$

$$I_{OB}^2\ R_{ON}(\text{Duty Cycle}_B)$$

where the duty cycle is the % time in the current source state. Substituting equations (1) and (5) into (2) yields:

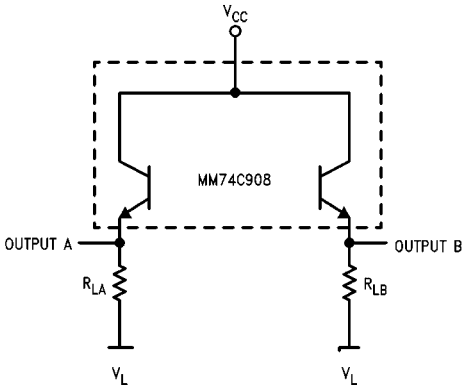
$$T_J = T_A + \theta_{JA}\ [9\ (T_J - 25)\ (0.008) + 9]: \quad (6a)$$

$$[I_{OA}^2\ (\text{Duty Cycle}_A) + I_{OB}^2\ (\text{Duty Cycle}_B)]$$

simplifying:

$$T_J = \frac{T_A + 7.2\ \theta_{JA}\ [I_{OA}^2\ (\text{Duty Cycle}_A) + I_{OB}^2\ (\text{Duty Cycle}_B)]}{1 - 0.072\ \theta_{JA}\ [I_{OA}^2\ (\text{Duty Cycle}_A) + I_{OB}^2\ (\text{Duty Cycle}_B)]}$$

Equations (1), (4), and (6b) can be used in an iterative method to determine the output current, output resistance and junction temperature.




For example, let $V_{CC}$ = 15V, $R_{LA}$ = 100Ω, $R_{LB}$ = 100Ω, $V_L$ = 0V, $T_A$ = 25°C, $\theta_{JA}$ = 110°C/W, Duty $\text{Cycle}_A$ = 50%, Duty $\text{Cycle}_B$ = 75%.

Assuming $R_{ON}$ = 11Ω, then:

$$I_{OA} = \frac{V_{CC} - V_L}{R_{ON} + R_{LA}} = \frac{15}{11 + 100} = 135.1\ \text{mA},$$

$$I_{OB} = \frac{V_{CC} - V_L}{R_{ON} + R_{LB}} = 135.1\ \text{mA}$$

and

$$T_J = \frac{T_A + 7.2\ \theta_{JA}\ [I_{OA}^2\ (\text{Duty Cycle}_A) + I_{OB}^2\ (\text{Duty Cycle}_B)]}{1 - 0.072\ \theta_{JA}\ [I_{OA}^2\ (\text{Duty Cycle}_A) + I_{OB}^2\ (\text{Duty Cycle}_B)]}$$

$$T_J = \frac{25 + (7.2)\ (110)\ [(0.1351)^2\ (0.5) + (0.1351)^2\ (0.75)]}{1 - (0.072)\ (110)\ [(0.1351)^2\ (0.5) + (0.1351)^2\ (0.75)]}$$

$$T_J = 52.6°C$$

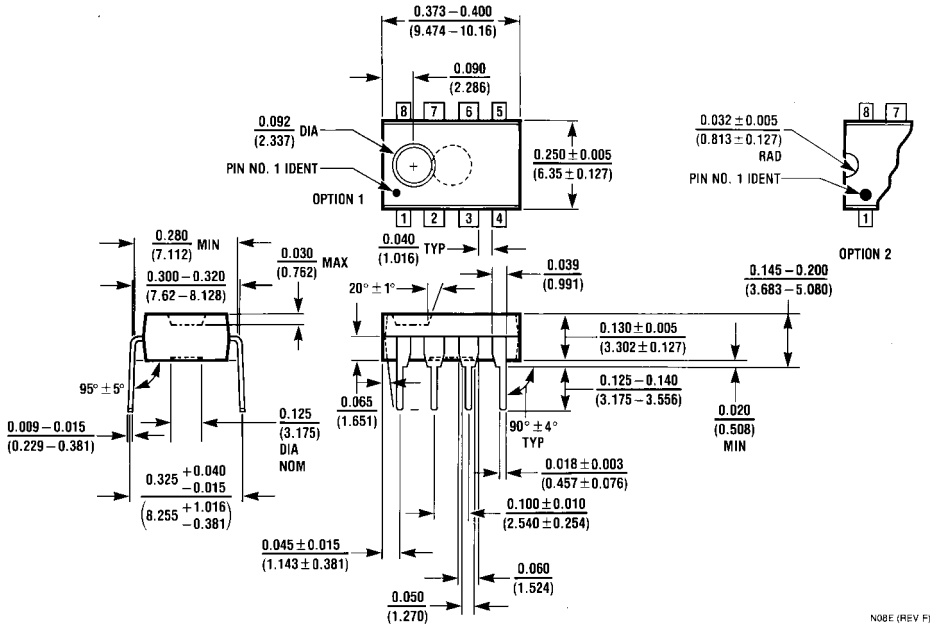
and $R_{ON} = 9\ (T_J - 25)\ (0.008) + 9$

$= 9(52.6 - 25)\ (0.008) + 9 = 11\Omega$

## Applications

(See AN-177 for applications)

## Physical Dimensions inches (millimeters) unless otherwise noted




**8-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide**
**Package Number N08E**

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