

## MM74C908/MM74C918 Dual CMOS 30V Relay Driver

### General Description

The MM74C908 and MM74C918 are general purpose dual high voltage drivers, each capable of sourcing a minimum of 250 mA at  $V_{OUT} = V_{CC} - 3V$ , and  $T_J = 65^\circ C$ .

The MM74C908 and MM74C918 consist 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.

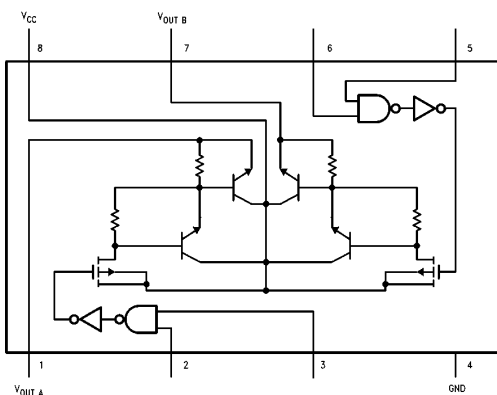
### Features

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

### Connection Diagrams

#### Dual-In-Line Package

##### MM74C908



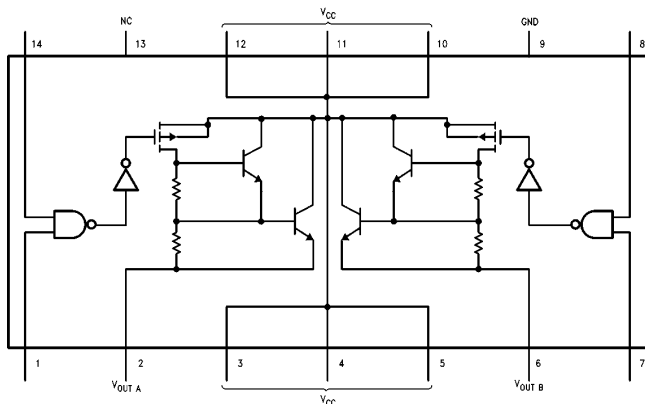
Top View

TL/F/5912-1

Order Number MM74C908

#### Dual-In-Line Package

##### MM74C918



Top View

TL/F/5912-2

Order Number MM74C918

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## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Voltage at any Input Pin	−0.3V to $V_{CC}$ + 0.3V
Voltage at any Output Pin	32V
Operating Temperature Range	
MM74C908/MM74C918	−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

## DC Electrical Characteristics Min/Max limits apply across temperature range, unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>CMOS TO CMOS</b>						
$V_{IN(1)}$	Logical “1” Input Voltage	$V_{CC} = 5V$ $V_{CC} = 10V$	3.5 8.0			V V
$V_{IN(0)}$	Logical “0” Input Voltage	$V_{CC} = 5V$ $V_{CC} = 10V$			1.5 2.0	V V
$I_{IN(1)}$	Logical “1” Input Current	$V_{CC} = 15V, V_{IN} = 15V$		0.005	1.0	$\mu A$
$I_{IN(0)}$	Logical “0” Input Current	$V_{CC} = 15V, V_{IN} = 0V$	−1.0	−0.005		$\mu A$
$I_{CC}$	Supply Current	$V_{CC} = 15V$ , Outputs Open Circuit		0.05	15	$\mu A$
	Output “OFF” Voltage	$V_{IN} = V_{CC}, I_{OUT} = -200 \mu A$		−30		V
<b>CMOS/LPTTL INTERFACE</b>						
$V_{IN(1)}$	Logical “1” Input Voltage MM74C908/MM74C918	$V_{CC} = 4.75V$	$V_{CC} - 1.5$			V
$V_{IN(0)}$	Logical “0” Input Voltage MM74C908/MM74C918	$V_{CC} = 4.75V$			0.8	V
<b>OUTPUT DRIVE</b>						
$V_{OUT}$	Output Voltage	$I_{OUT} = -300 mA, V_{CC} \geq 5V, T_J = 25^\circ C$ $I_{OUT} = -250 mA, V_{CC} \geq 5V, T_J = 65^\circ C$ $I_{OUT} = -175 mA, V_{CC} \geq 5V, T_J = 150^\circ C$	$V_{CC} - 2.7$ $V_{CC} - 3.0$ $V_{CC} - 3.15$	$V_{CC} - 1.8$ $V_{CC} - 1.9$ $V_{CC} - 2.0$		V V V
$R_{ON}$	Output Resistance	$I_{OUT} = -300 mA, V_{CC} \geq 5V, T_J = 25^\circ C$ $I_{OUT} = -250 mA, V_{CC} \geq 5V, T_J = 65^\circ C$ $I_{OUT} = -175 mA, V_{CC} \geq 5V, T_J = 150^\circ C$		6.0 7.5 10	9.0 12 18	$\Omega$ $\Omega$ $\Omega$
	Output Resistance Coefficient			0.55	0.80	%/°C
$\theta_{JA}$	Thermal Resistance MM74C908/MM74C918	(Note 3) (Note 3)		100 45	110 55	°C/W °C/W

## AC Electrical Characteristics\*

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{pd1}$	Propagation Delay to a Logical “1”	$V_{CC} = 5V, R_L = 50\Omega,$ $C_L = 50 pF, T_A = 25^\circ C$ $V_{CC} = 10V, R_L = 50\Omega,$ $C_L = 50 pF, T_A = 25^\circ C$		150 65	300 120	ns ns
$t_{pd0}$	Propagation Delay to a Logic “0”	$V_{CC} = 5V, R_L = 50\Omega,$ $C_L = 50 pF, T_A = 25^\circ C$ $V_{CC} = 10V, R_L = 50\Omega,$ $C_L = 50 pF, T_A = 25^\circ C$		2.0 4.0	10 20	$\mu s$ $\mu s$
$C_{IN}$	Input Capacitance	(Note 2)		5.0		pF

\*AC Parameters are guaranteed by DC correlated testing.

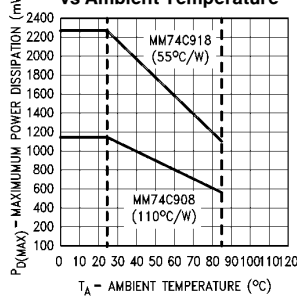
**Note 1:** “Absolute Maximum Ratings” are those values beyond which the safety of the device cannot be guaranteed. Except for “Operating Temperature Range” they are not meant to imply that the devices should be operated at these limits. The table of “Electrical Characteristics” provides conditions for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

**Note 2:** Capacitance is guaranteed by periodic testing.

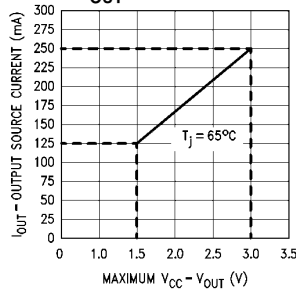
**Note 3:**  $\theta_{JA}$  measured in free air with device soldered into printed circuit board.

## Typical Performance Characteristics

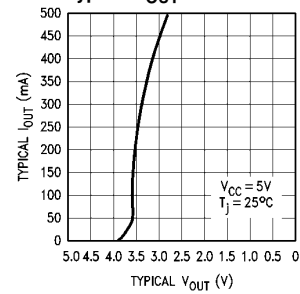
**Maximum Power Dissipation vs Ambient Temperature**



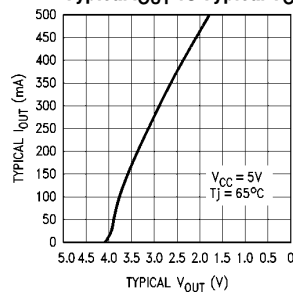
**Maximum  $V_{CC} - V_{OUT}$  vs  $I_{OUT}$**



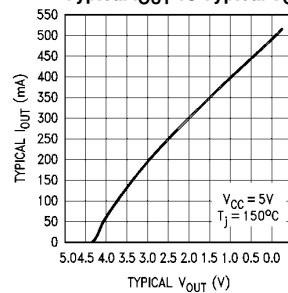
**Typical  $I_{OUT}$  vs Typical  $V_{OUT}$**



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

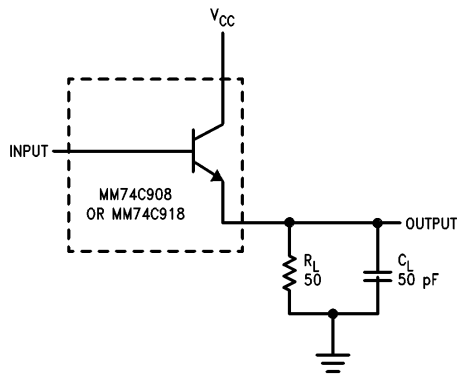


**Typical  $I_{OUT}$  vs Typical  $V_{OUT}$**



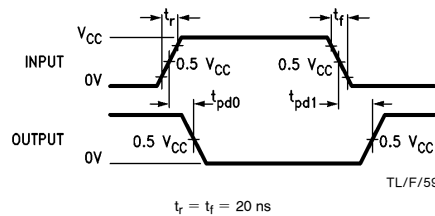
TL/F/5912-3

## AC Test Circuit



TL/F/5912-4

## Switching Time Waveforms



TL/F/5912-5

$$t_r = t_f = 20\text{ ns}$$

## Power Considerations

### Calculating Output “ON” Resistance ( $R_L > 18\Omega$ )

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:

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

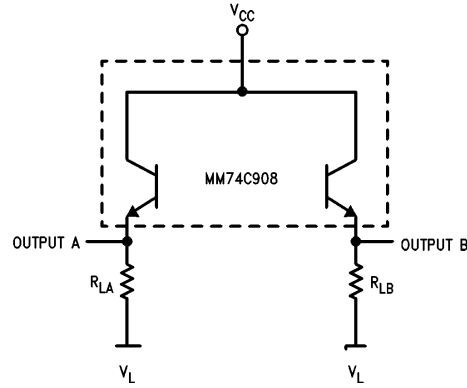
where the duty cycle is the % time in the current source state. Substituting equations (1) and (5) into (2) yields:

$$T_J = T_A + \theta_{JA} [9 (T_J - 25) (0.008) + 9] [I_{OA}^2 (\text{Duty Cycle}_A) + I_{OB}^2 (\text{Duty Cycle}_B)] \quad (6a)$$

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.



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

Assuming  $R_{ON} = 11\Omega$ , 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

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

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

$$T_J = 52.6^\circ C$$

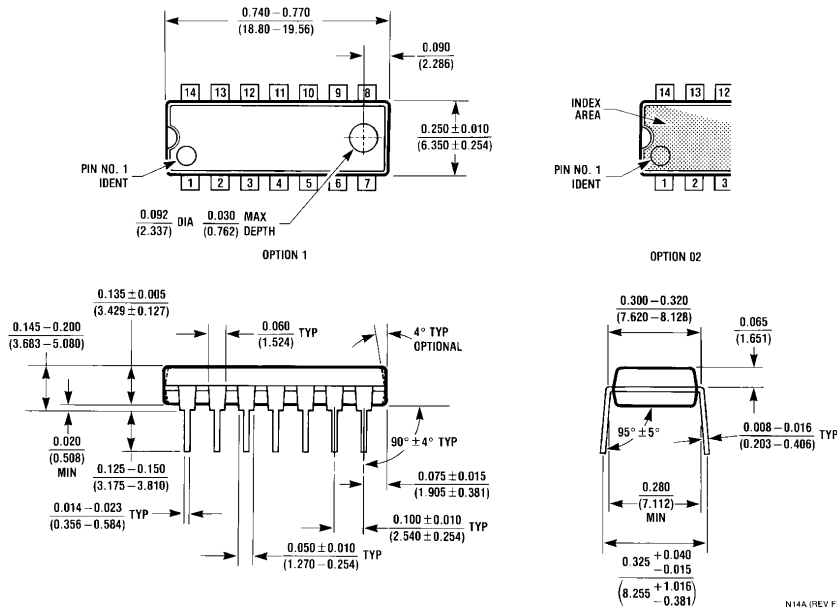
$$\begin{aligned} \text{and } R_{ON} &= 9 (T_J - 25) (0.008) + 9 \\ &= 9(52.6 - 25) (0.008) + 9 = 11\Omega \end{aligned}$$

## Applications

(See AN-177 for applications)

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## Physical Dimensions inches (millimeters) (Continued)



**Molded Dual-In-Line Package (N)**  
**Order Number MM74C918N**  
**NS Package Number N14A**

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