National Semiconductor

MM74C908/MM74C918 Dual CMOS 30-Volt 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 $T_J = +65°C$.

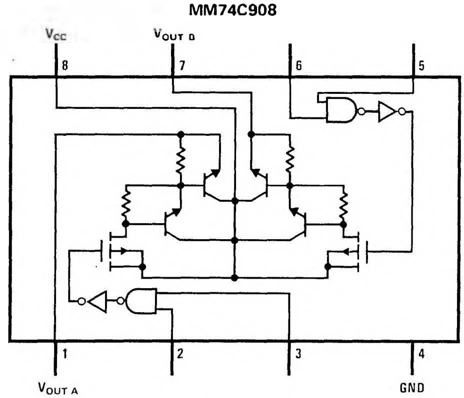
The MM74C908 and MM74C918 consist of two CMOS NAND gates driving an emitter follower darlington output to achieve high current drive and high voltage capabilities. In the "OFF" state the outputs can withstand a maximum of −30V across the device. These CMOS drivers are useful in interfacing normal CMOS 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 — 8Ω (typ.)
- High voltage — −30V
- High current — 250 mA

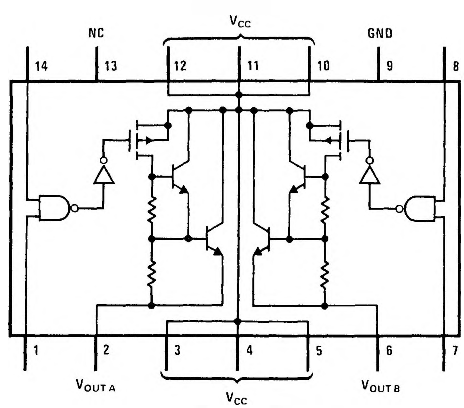
Connection Diagrams

MM74C908



TOP VIEW

MM74C918



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	
MM74C908/MM74C918	−40°C to +85°C
Operating V_{CC} Range	3V to 18V
Absolute Maximum V_{CC}	19V
I_{SOURCE}	500mA
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C
Package Dissipation	Refer to Maximum Power Dissipation vs Ambient Temperature Graph

DC Electrical Characteristics Min/max limits apply across temperature range unless otherwise noted.

	Parameter	Conditions	Min.	Typ.	Max.	Units
	CMOS to CMOS					
$V_{IN(1)}$	Logical "1" Input Voltage	V_{CC} = 5.0V	3.5			V
		V_{CC} = 10V	8.0			V
$V_{IN(0)}$	Logical "0" Input Voltage	V_{CC} = 5.0V			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} = −200μA		−30		V
	CMOS/LPTTL Interface					
$V_{IN(1)}$	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
	Output Drive					
V_{OUT}	Output Voltage	I_{OUT} = −300mA, V_{CC} ≥ 5.0V, T_J = 25°C	V_{CC} − 2.7	V_{CC} − 1.8		V
		I_{OUT} = −250mA, V_{CC} ≥ 5.0V, T_J = 65°C	V_{CC} − 3.0	V_{CC} − 1.9		V
		I_{OUT} = −175mA, V_{CC} ≥ 5.0V, T_J = 150°C	V_{CC} − 3.15	V_{CC} − 2.0		V
R_{ON}	Output Resistance	I_{OUT} = −300mA, V_{CC} ≥ 5.0V, T_J = 25°C		6.0	9.0	Ω
		I_{OUT} = −250mA, V_{CC} ≥ 5.0V, T_J = 65°C		7.5	12	Ω
		I_{OUT} = −175mA, V_{CC} ≥ 5.0V, T_J = 150°C		10	18	Ω
	Output Resistance Coefficient			0.55	0.80	%/°C
θ_{JA}	Thermal Resistance MM74C908	(Note 3)		100	110	°C/W
	MM74C918	(Note 3)		45	55	°C/W

AC Electrical Characteristics

	Parameter	Conditions	Min.	Typ.	Max.	Units
t_{pd1}	Propagation Delay to a Logic "1"	V_{CC} = 5.0V, R_L = 50Ω, C_L = 50pF, T_A = 25°C		150	300	ns
		V_{CC} = 10V, R_L = 50Ω, C_L = 50pF, T_A = 25°C		65	120	ns
t_{pd0}	Propagation Delay to a Logic "0"	V_{CC} = 5.0V, R_L = 50Ω, C_L = 50pF, T_A = 25°C		2.0	10	μs
		V_{CC} = 10V, R_L = 50Ω, C_L = 50pF, T_A = 25°C		4.0	20	μs
C_{IN}	Input Capacitance	(Note 2)		5.0		pF

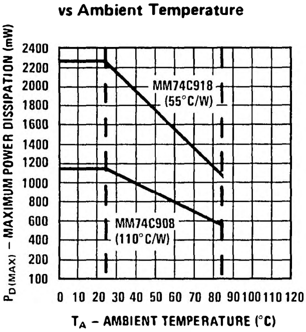
Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual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

Note 2: Capacitance is guaranteed by periodic testing.

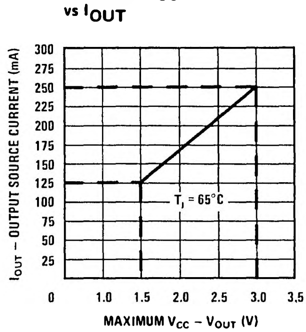
Note 3: θ_{JA} measured in free air with device soldered into printed circuit board.

Typical Performance Characteristics

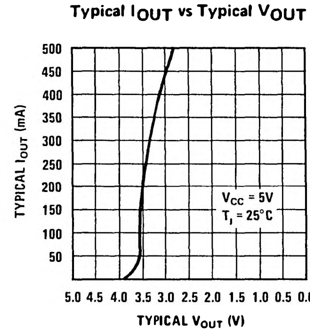
Maximum Power Dissipation vs Ambient Temperature



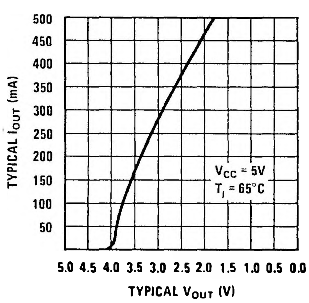
Maximum $V_{CC} - V_{OUT}$ vs I_{OUT}



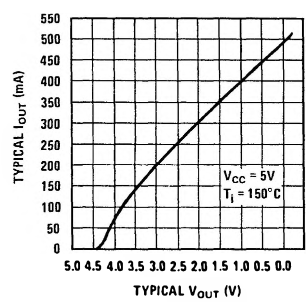
Typical I_{OUT} vs Typical V_{OUT}



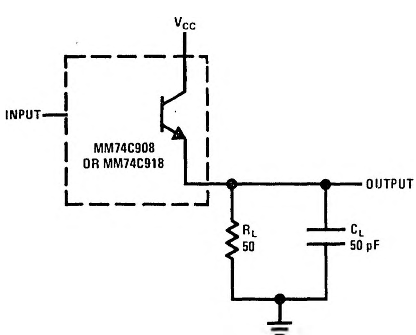
Typical I_{OUT} vs Typical V_{OUT}



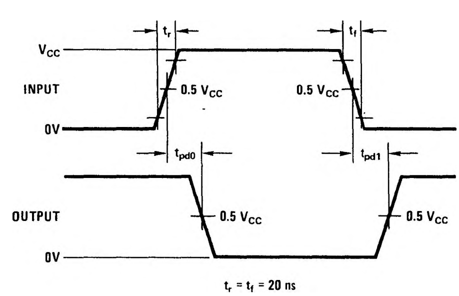
Typical I_{OUT} vs Typical V_{OUT}



AC Test Circuit



Switching Time Waveforms



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:

$$R_{ON} = 9\ (T_j - 25)\ (0.008) + 9 \qquad (1)$$

and T_j is given by:

$$T_j = T_A + P_{DAV}\ \theta_{jA}, \qquad (2)$$

where T_A = ambient temperature, θ_{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:

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

where I_O is the output current, given by:

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

V_L is the load voltage.

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

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

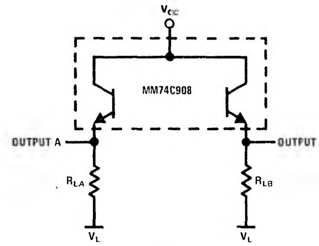
where the duty cycle is the % time in the current source state. Substituting equations (1) and (5) into (2) yields:

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

simplifying:

$$T_j = \frac{T_A + 7.2\ \theta_{jA}\ [I_{OA}^2\ (\text{Duty Cycle}_A) + I_{OB}^2\ (\text{Duty Cycle}_B)]}{1 - 0.072\ \theta_{jA}\ [I_{OA}^2\ (\text{Duty Cycle}_A) + I_{OB}^2\ (\text{Duty Cycle}_B)]} \qquad (6b)$$

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, θ_{jA} = 110°C/W, Duty Cycle_A = 50%, Duty 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.)