MC1488L

LINEAR/DIGITAL INTERFACE CIRCUITS

QUAD LINE DRIVER

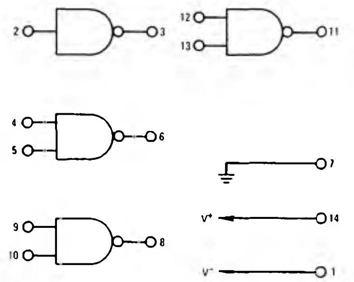
The MC1488L is a monolithic quad line driver designed to interface data terminal equipment with data communications equipment in conformance with the specifications of EIA Standard No. RS-232C.

Features:

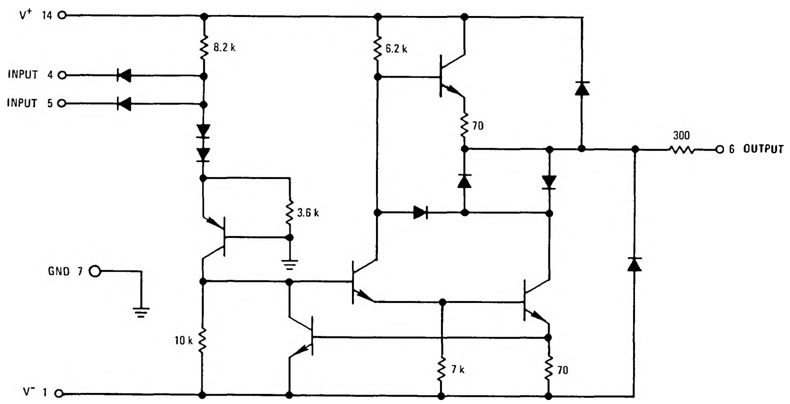
- Current Limited Output
  10 mA typ
- Power-Off Source Impedance
  300 Ohms min
- Simple Slew Rate Control with External Capacitor
- Flexible Operating Supply Range
- Compatible with All Motorola DTL and TTL Logic Families

QUAD MDTL LINE DRIVER
RS-232C
INTEGRATED CIRCUIT

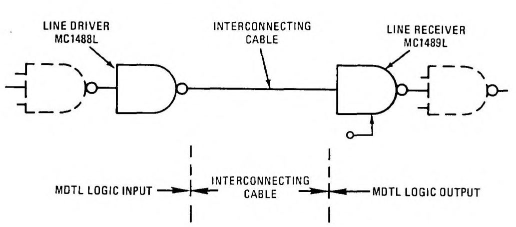
LOGIC DIAGRAM

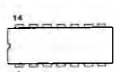


CIRCUIT SCHEMATIC
1/4 OF CIRCUIT SHOWN

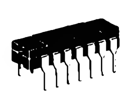


TYPICAL APPLICATION





(top view)



CERAMIC PACKAGE
CASE 632
TO-116

See Packaging Information Section for outline dimensions.

Maximum Rating (T_A = +25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	V^+ V^-	+15 −15	Vdc
Input Signal Voltage	V_{in}	$-15 \leq V_{in} \leq 7.0$	Vdc
Output Signal Voltage	V_o	±15	Vdc
Power Derating (Package Limitation, Ceramic Dual-In-Line Package) Derate above T_A = +25°C	P_D $1/\theta_{JA}$	1000 6.7	mW mW/°C
Operating Temperature Range	T_A	0 to +75	°C
Storage Temperature Range	T_{stg}	-65 to +175	°C

ELECTRICAL CHARACTERISTICS (V^+ = +9.0 ± 1% Vdc, V^- = -9.0 ± 1% Vdc, T_A = 0 to +75°C unless otherwise noted)

Characteristic	Figure	Symbol	Min	Typ	Max	Unit
Forward Input Current (V_{in} = 0 Vdc)	1	I_F	–	1.0	1.6	mA
Reverse Input Current (V_{in} = +5.0 Vdc)	1	I_R	–	–	10	μA
Output Voltage High	2	V_{OH}				Vdc
(V_{in} = 0.8 Vdc, R_L = 3.0 kΩ, V^+ = +9.0 Vdc, V^- = -9.0 Vdc)			+6.0	+7.0	–	
(V_{in} = 0.8 Vdc, R_L = 3.0 kΩ, V^+ = +13.2 Vdc, V^- = -13.2 Vdc)			+9.0	+10.5	–	
Output Voltage Low	2	V_{OL}				Vdc
(V_{in} = 1.9 Vdc, R_L = 3.0 kΩ, V^+ = +9.0 Vdc, V^- = -9.0 Vdc)			-6.0	-7.0	–	
(V_{in} = 1.9 Vdc, R_L = 3.0 kΩ, V^+ = +13.2 Vdc, V^- = -13.2 Vdc)			-9.0	-10.5	–	
Positive Output Short-Circuit Current	3	I_{SC+}	+6.0	+10	+12	mA
Negative Output Short-Circuit Current	3	I_{SC-}	-6.0	-10	-12	mA
Output Resistance ($V^+ = V^- = 0$, $\|V_o\|$ = ±2.0 V)	4	R_o	300	–	–	Ohms
Positive Supply Current (R_L = ∞)	5	I^+				mA
(V_{in} = 1.9 Vdc, V^+ = +9.0 Vdc)			–	+15	+20	
(V_{in} = 0.8 Vdc, V^+ = +9.0 Vdc)			–	+4.5	+6.0	
(V_{in} = 1.9 Vdc, V^+ = +12 Vdc)			–	+19	+25	
(V_{in} = 0.8 Vdc, V^+ = +12 Vdc)			–	+5.5	+7.0	
(V_{in} = 1.9 Vdc, V^+ = +15 Vdc)			–	–	+34	
(V_{in} = 0.8 Vdc, V^+ = +15 Vdc)			–	–	+12	
Negative Supply Current (R_L = ∞)	5	I^-				mA
(V_{in} = 1.9 Vdc, V^- = -9.0 Vdc)			–	-13	-17	
(V_{in} = 0.8 Vdc, V^- = -9.0 Vdc)			–	0	0	
(V_{in} = 1.9 Vdc, V^- = -12 Vdc)			–	-18	-23	
(V_{in} = 0.8 Vdc, V^- = -12 Vdc)			–	0	0	
(V_{in} = 1.9 Vdc, V^- = -15 Vdc)			–	–	-34	
(V_{in} = 0.8 Vdc, V^- = -15 Vdc)			–	–	-2.5	
Power Dissipation		P_D				mW
(V^+ = 9.0 Vdc, V^- = -9.0 Vdc)			–	–	333	
(V^+ = 12 Vdc, V^- = -12 Vdc)			–	–	576	

SWITCHING CHARACTERISTICS (V^+ = +9.0 ± 1% Vdc, V^- = -9.0 ± 1% Vdc, T_A = +25°C)

Propagation Delay Time (Z_L = 3.0 k and 15 pF)	6	t_{pd}^+	–	150	200	ns
Fall Time (Z_L = 3.0 k and 15 pF)	6	t_f	–	45	75	ns
Propagation Delay Time (Z_L = 3.0 k and 15 pF)	6	t_{pd}^-	–	65	120	ns
Rise Time (Z_L = 3.0 k and 15 pF)	6	t_r	–	55	100	ns

CHARACTERISTIC DEFINITIONS

FIGURE 1 — INPUT CURRENT

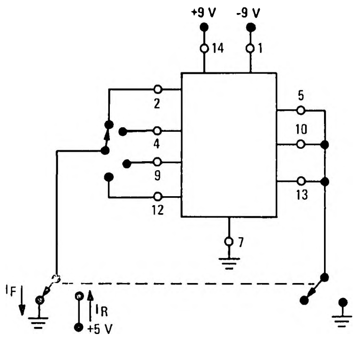


FIGURE 2 — OUTPUT VOLTAGE

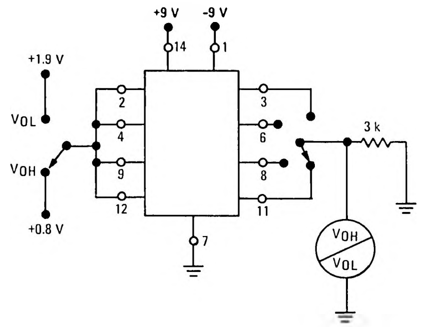


FIGURE 3 — OUTPUT SHORT-CIRCUIT CURRENT

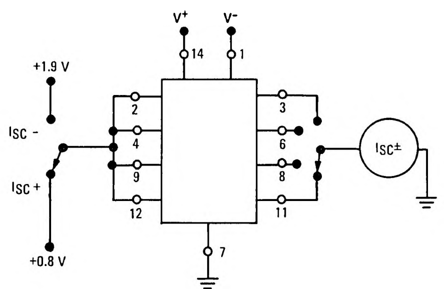


FIGURE 4 — OUTPUT RESISTANCE (POWER-OFF)

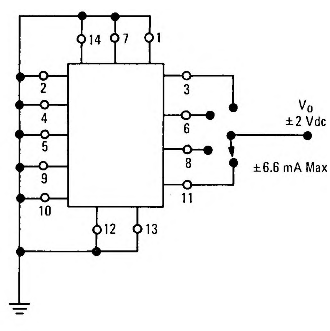


FIGURE 5 — POWER-SUPPLY CURRENTS

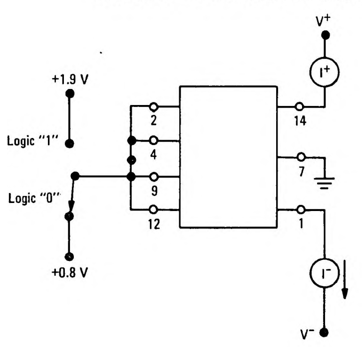
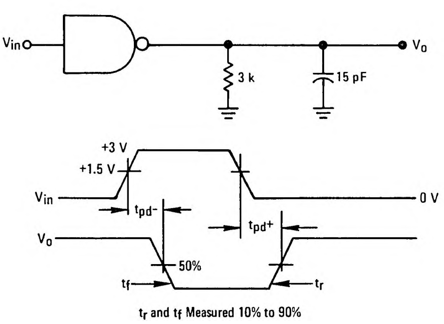


FIGURE 6 — SWITCHING RESPONSE



t_r and t_f Measured 10% to 90%

TYPICAL CHARACTERISTICS

(T_A = +25°C unless otherwise noted)

FIGURE 7 – TRANSFER CHARACTERISTICS versus POWER-SUPPLY VOLTAGE

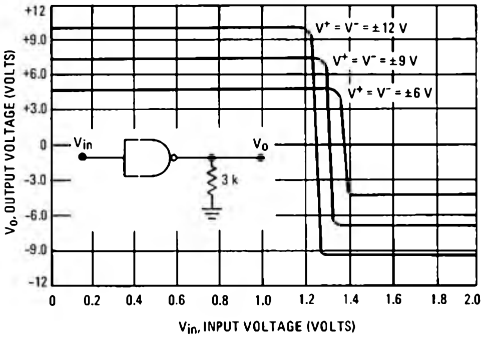


FIGURE 8 – SHORT-CIRCUIT OUTPUT CURRENT versus TEMPERATURE

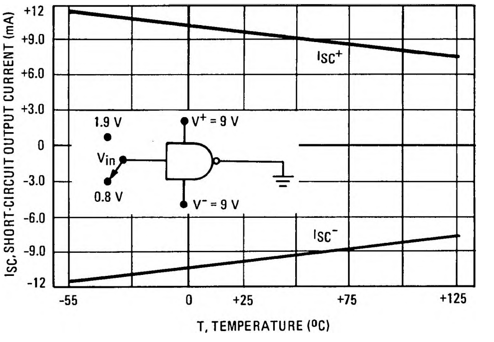


FIGURE 9 – OUTPUT SLEW RATE versus LOAD CAPACITANCE

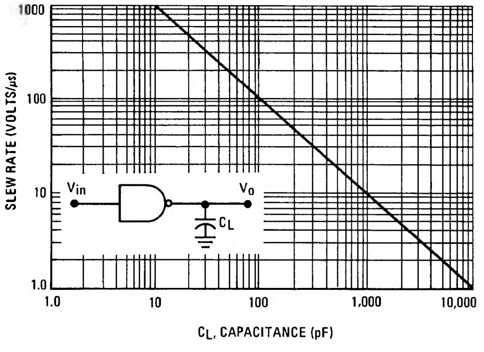


FIGURE 10 – OUTPUT VOLTAGE AND CURRENT-LIMITING CHARACTERISTICS

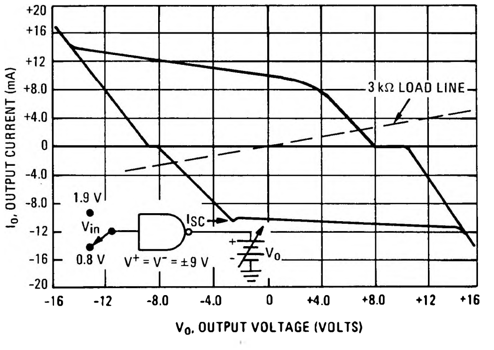
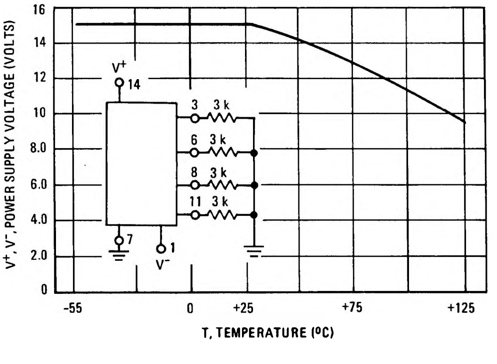


FIGURE 11 – MAXIMUM OPERATING TEMPERATURE versus POWER-SUPPLY VOLTAGE



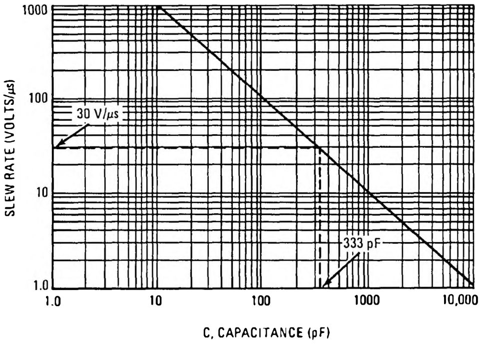
APPLICATIONS INFORMATION

The Electronic Industries Association (EIA) has released the RS232C specification detailing the requirements for the interface between data processing equipment and data communications equipment. This standard specifies not only the number and type of interface leads, but also the voltage levels to be used. The MC1488L quad driver and its companion circuit, the MC1489L quad receiver, provide a complete interface system between DTL or TTL logic levels and the RS232C defined levels. The RS232C requirements as applied to drivers are discussed herein.

The required driver voltages are defined as between 5 and 15-volts in magnitude and are positive for a logic "0" and negative for a logic "1". These voltages are so defined when the drivers are terminated with a 3000 to 7000-ohm resistor. The MC1488L meets this voltage requirement by converting a DTL/TTL logic level into RS232C levels with one stage of inversion.

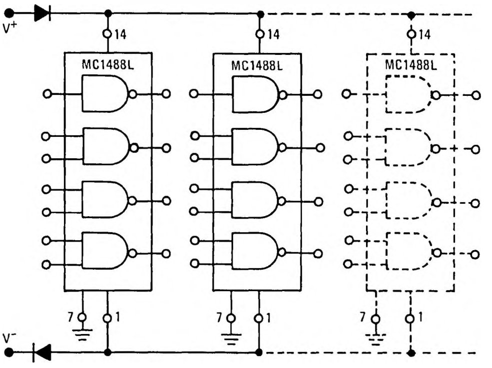
The RS232C specification further requires that during transitions, the driver output slew rate must not exceed 30 volts per microsecond. The inherent slew rate of the MC1488L is much too fast for this requirement. The current limited output of the device can be used to control this slew rate by connecting a capacitor to each driver output. The required capacitor can be easily determined by using the relationship $C = I_{SC} \times \Delta T/\Delta V$ from which Figure 12 is derived. Accordingly, a 330 pF capacitor on each output will guarantee a worst case slew rate of 30 volts per microsecond.

FIGURE 12 – SLEW RATE versus CAPACITANCE FOR I_{SC} = 10 mA



The interface driver is also required to withstand an accidental short to any other conductor in an interconnecting cable. The worst possible signal on any conductor would be another driver using a plus or minus 15 volt, 500 mA source. The MC1488L is designed to indefinitely withstand such a short to all four outputs in a package as long as the power-supply voltages are greater than 9.0 volts (i.e., $V^+ \geq 9.0$ V; $V^- \leq -9.0$ V). In some power-supply designs, a loss of system power causes a low impedance on the power-supply outputs. When this occurs, a low impedance to ground would exist at the power inputs to the MC1488L effectively shorting the 300-ohm output resistors to ground. If all four outputs were then shorted to plus or minus 15 volts, the power dissipation in these resistors would be excessive. Therefore, if the system is designed to permit low impedances to ground at the power-supplies of the drivers, a diode should be placed in each power-supply lead to prevent overheating in this fault condition. These two diodes, as shown in Figure 13, could be used to decouple all the driver packages in a system. (These same diodes will allow the MC1488L to withstand momentary shorts to the ±25-volt limits specified in the earlier Standard RS232B.) The addition of the diodes also permits the MC1488L to withstand faults with power-supplies of less than the 9.0 volts stated above.

FIGURE 13 – POWER-SUPPLY PROTECTION TO MEET POWER-OFF FAULT CONDITIONS



The maximum short-circuit current allowable under fault conditions is more than guaranteed by the previously mentioned 10 mA output current limiting.

Other Applications

The MC1488L is an extremely versatile line driver with a myriad of possible applications. Several features of the drivers enhance this versatility:

1. Output Current Limiting – this enables the circuit designer to define the output voltage levels independent of power-supplies and can be accomplished by diode clamping of the output pins. Figure 14 shows the MC1488L used as a DTL to MOS translator where the high-level voltage output is clamped one diode above ground. The resistor divider shown is used to reduce the output voltage below the 300 mV above ground MOS input level limit.

2. Power-Supply Range – as can be seen from the schematic drawing of the drivers, the positive and negative driving elements of the device are essentially independent and do not require matching power-supplies. In fact, the positive supply can vary from a minimum seven volts (required for driving the negative pulldown section) to the maximum specified 15 volts. The negative supply can vary from approximately -2.5 volts to the minimum specified -15 volts. The MC1488L will drive the output to within 2 volts of the positive or negative supplies as long as the current output limits are not exceeded. The combination of the current-limiting and supply-voltage features allow a wide combination of possible outputs within the same quad package. Thus if only a portion of the four drivers are used for driving RS232C lines, the remainder could be used for DTL to MOS or even DTL to DTL translation. Figure 15 shows one such combination.

FIGURE 14 – MDTL/MTTL-TO-MOS TRANSLATOR

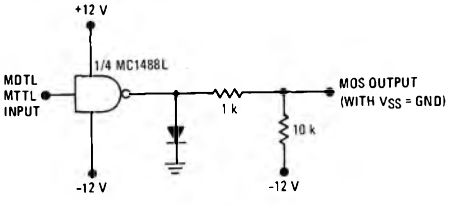


FIGURE 15 – LOGIC TRANSLATOR APPLICATIONS