⨁ MOTOROLA ━━━━━━━━

Quad Low Power Line Driver

The MC14C88B is a low power monolithic quad line driver, using BiMOS technology, which conforms to EIA–232–D, EIA–562, and CCITT V.28. The inputs feature TTL and CMOS compatibility with minimal loading. The outputs feature internally controlled slew rate limiting, eliminating the need for external capacitors. Power off output impedance exceeds 300 Ω, and current limiting protects the outputs in the event of short circuits.

Power supply current is less than 160 µA over the supply voltage range of ±4.5 to ±15 V. EIA–232–D performance is guaranteed with a minimum supply voltage of ±6.5 V.

The MC14C88B is pin compatible with the MC1488, SN75188, SN75C188, DS1488, and DS14C88. This device is available in 14 pin plastic DIP, and surface mount packaging.

Features:

- BiMOS Technology for Low Power Operation (< 5.0 mW)
- Meets Requirements of EIA–232–D, EIA–562, and CCITT V.28
- Quiescent Current Less Than 160 µA
- TTL/CMOS Compatible Inputs
- Minimum 300 Ω Output Impedance when Powered Off
- Supply Voltage Range: ±4.5 to ±15 V
- Pin Equivalent to MC1488
- Current Limited Output: 10 mA Minimum
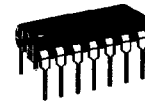- Operating Ambient Temperature: –40° to 85°C

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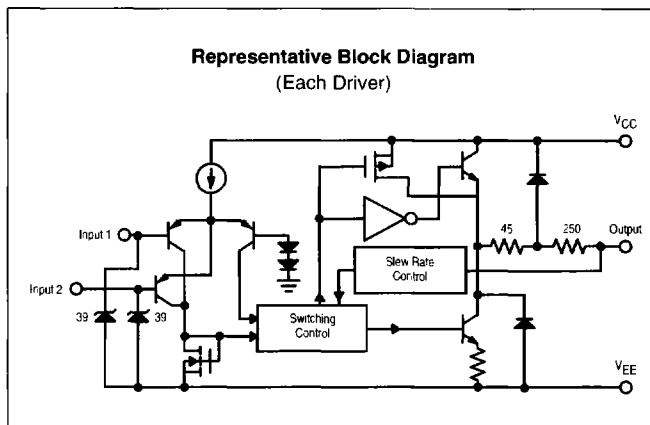
MC14C88B

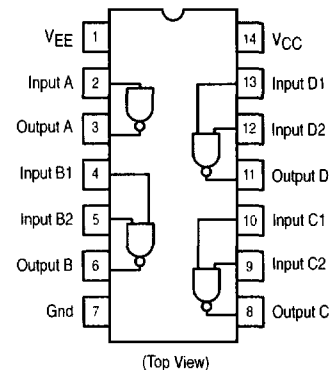### QUAD LOW POWER LINE DRIVER

SEMICONDUCTOR TECHNICAL DATA

P SUFFIX
PLASTIC PACKAGE
CASE 646

D SUFFIX
PLASTIC PACKAGE
CASE 751A
(SO–14)

PIN CONNECTIONS

V_{EE}	1	14	V_{CC}
Input A	2	13	Input D1
Output A	3	12	Input D2
Input B1	4	11	Output D
Input B2	5	10	Input C1
Output B	6	9	Input C2
Gnd	7	8	Output C

(Top View)

Representative Block Diagram
(Each Driver)

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC14C88BP	$T_A = -40°$ to +85°C	Plastic DIP
MC14C88BD		SO–14

MAXIMUM RATINGS (T_A = +25°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Power Supply Voltage $V_{CC(max)}$ $V_{EE(min)}$ $(V_{CC} - V_{EE})max$	V_{CC} V_{EE} $V_{CC} - V_{EE}$	+17 −17 34	Vdc
Input Voltage (All Inputs)	V_{in}	V_{EE}−0.3, V_{EE}+39	Vdc
Applied Output Voltage, when $V_{CC}=V_{EE}\neq0$ V Applied Output Voltage, when $V_{CC}=V_{EE}=0$ V	V_X	V_{EE}−6.0 V, V_{CC}+6.0 V ±15	Vdc
Output Current	I_O	Self Limiting	mA
Operating Junction Temperature	T_J	− 65, + 150	°C

Devices should not be operated at these limits. The "Recommended Operating Conditions" table provides for actual device operation.

RECOMMENDED OPERATING CONDITIONS

Characteristic	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V_{CC} V_{EE}	+4.5 −15	– –	+15 −4.5	Vdc
Input Voltage (All Inputs)	V_{in}	0	–	V_{CC}	Vdc
Applied Output Voltage ($V_{CC}=V_{EE}=0$ V)	V_O	−2.0	0	+2.0	Vdc
Output DC Load	R_L	3.0	–	7.0	kΩ
Operating Ambient Temperature Range	T_A	−40	–	+85	°C

All limits are not necessarily functional concurrently.

ELECTRICAL CHARACTERISTICS ($-40°C \leq T_A \leq +85°C$, unless otherwise noted.)*

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current (I_{out} = 0, see Figure 2) I_{CC} @ 4.75 V ≤ V_{CC}, $-V_{EE}$ ≤ 15 V Outputs High Outputs Low I_{EE} Outputs High Outputs Low	 I_{CC} (OH) I_{CC} (OL) I_{EE} (OH) I_{EE} (OL)	 – – −160 −160	 – – – –	 160 160 – –	µA
Output Voltage – High, V_{in} ≤ 0.8 V (R_L = 3.0 kΩ, see Figure 3) V_{CC} = +4.75 V, V_{EE} = −4.75 V V_{CC} = +5.0 V, V_{EE} = −5.0 V V_{CC} = +6.5 V, V_{EE} = −6.5 V V_{CC} = +12 V, V_{EE} = −12 V V_{CC} = +13.2 V, V_{EE} = −13.2 V ($R_L = \infty$) Output Voltage – Low, V_{in} ≥ 2.0 V V_{CC} = +4.75 V, V_{EE} = −4.75 V V_{CC} = +5.0 V, V_{EE} = −5.0 V V_{CC} = +6.5 V, V_{EE} = −6.5 V V_{CC} = +12 V, V_{EE} = −12 V V_{CC} = +13.2 V, V_{EE} = −13.2 V ($R_L = \infty$)	V_{OH} V_{OL}	 3.7 4.0 5.0 10 – – – – – −13.2	 3.8 4.3 6.1 10.5 13.2 −3.8 −4.2 −6.0 −10.5 −13.2	 – – – – 13.2 −3.7 −4.0 −5.0 −10 –	Vdc
Output Short Circuit Current** (see Figure 4) ($V_{CC} = \|V_{EE}\| = 15$ V) Normally High Output, shorted to ground Normally Low Output, shorted to ground	I_{OS}	 −35 +10	 – –	 −10 +35	mA
Output Source Resistance ($V_{CC} = V_{EE} = 0$ V, −2.0 V ≤ V_{out} ≤ +2.0 V)	R_O	300	–	–	Ω
Input Voltage Low Level High Level	 V_{IL} V_{IH}	 0 2.0	 – –	 0.8 V_{CC}	Vdc

* Typicals reflect performance @ T_A = 25°C
** Only one output shorted at a time, for not more than 1 second.

ELECTRICAL CHARACTERISTICS (continued) (−40°C ≤ T_A ≤ +85°C, unless otherwise noted.)*

Characteristic	Symbol	Min	Typ	Max	Unit
Input Current	I_{in}				μA
V_{in} = 0 V, V_{CC} = |V_{EE}| = 4.75 V		−10	−0.1	0	
V_{in} = 0 V, V_{CC} = |V_{EE}| = 15 V		−10	−0.1	0	
V_{in} = 4.5 V, V_{CC} = |V_{EE}| = 4.75 V		0	+0.1	+10	
V_{in} = 4.5 V, V_{CC} = |V_{EE}| = 15 V		0	+0.1	+10	

TIMING CHARACTERISTICS (−40°C ≤ T_A ≤ +85°C, unless otherwise noted.)*

Characteristic	Symbol	Min	Typ	Max	Unit
Output Rise Time					μs
V_{CC} = 4.75 V, V_{EE} = −4.75 V					
−3.3 V ≤ V_O ≤ 3.3 V	t_{R1}				
C_L = 15 pF		0.22	0.66	2.1	
C_L = 1000 pF		0.22	1.52	2.1	
−3.0 V ≤ V_O ≤ 3.0 V	t_{R2}				
C_L = 15 pF		0.20	0.51	1.5	
C_L = 1000 pF		0.20	1.16	1.5	
V_{CC} = 12.0 V, V_{EE} = −12.0 V					
−3.0 V ≤ V_O ≤ 3.0 V					
C_L = 15 pF		0.20	0.62	1.5	
C_L = 2500 pF		0.20	0.82	1.5	
10% ≤ V_O ≤ 90%	t_{R3}				
C_L = 15 pF		0.53	1.41	3.2	
Output Fall Time					μs
V_{CC} = 4.75 V, V_{EE} = −4.75 V					
3.3 V ≤ V_O ≤ −3.3 V	t_{F1}				
C_L = 15 pF		0.22	0.93	2.1	
C_L = 1000 pF		0.22	1.28	2.1	
3.0 V ≤ V_O ≤ −3.0 V	t_{F2}				
C_L = 15 pF		0.20	0.72	1.5	
C_L = 1000 pF		0.20	1.01	1.5	
V_{CC} = 12.0 V, V_{EE} = −12.0 V					
3.0 V ≤ V_O ≤ −3.0 V					
C_L = 15 pF		0.20	0.70	1.5	
C_L = 2500 pF		0.20	0.94	1.5	
90% ≤ V_O ≤ 10%	t_{F3}				
C_L = 15 pF		0.53	1.71	3.2	
Output Slew Rate, 3.0 kΩ < R_L < 7.0 kΩ , 15 pF < C_L < 2500 pF	S_R	4.0	−	30	V/μs
Propagation Delay A (C_L = 15 pF, see Figure 1)					μs
V_{CC} = 12.0 V, V_{EE} = −12.0 V					
Input to Output – Low to High	t_{PLH}	−	0.9	3.0	
Input to Output – High to Low	t_{PHL}	−	2.3	3.5	
Propagation Delay B (C_L = 15 pF, see Figure 1)					
V_{CC} = 4.75 V, V_{EE} = −4.75 V					
Input to Output – Low to High	t_{PLH}	−	0.4	2.0	
Input to Output – High to Low	t_{PHL}	−	1.5	2.5	

* Typicals reflect performance @ T_A = 25°C

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Figure 1. Timing Diagram

NOTES: S.G. set to: f = 20 kHz for Propogation Delay A and f = 64 kHz for Propagation Delay B; Duty Cycle = 50%; t_R, $t_F \leq 5.0$ ns

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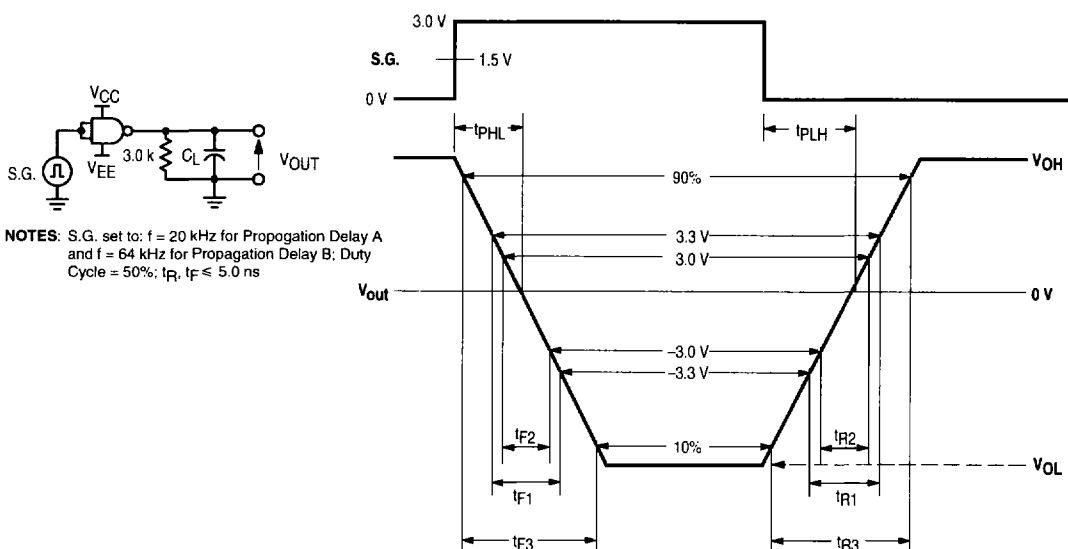
STANDARDS COMPLIANCE

The MC14C88 is designed to comply with EIA–232–D (formerly RS–232), the newer EIA–562 (which is a higher speed version of the EIA–232), and CCITT's V.28. EIA–562 was written around modern integrated circuit technology, whereas EIA–232 retains many of the specs written around the electro–mechanical circuitry in use at the time of its creation. Yet the user will find enough similarities to allow a certain amount of compatibility among equipment built to the two standards. Following is a summary of the key specifications relating to the systems and the drivers.

| Parameter	EIA–232–D	EIA–562
Maximum Data Rate	20 kbaud	38.4 kbaud Asynchronous 64 kbaud Synchronous
Maximum Cable Length	50 feet	Based on cable capacitance/data rate
Maximum Slew Rate	≤ 30 V/μs anywhere on the waveform	≤ 30 V/μs anywhere on the waveform ≥ 4.0 V/μs between +3.0 and –3.0 V
Transition Region	–3.0 to +3.0 V	–3.3 to +3.3 V
Transition Time	For UI ≥ 25 ms, $t_R \leq 1.0$ ms For 25 ms > UI > 125 μs, $t_R \leq 4\%$ UI For UI < 125 μs, $t_R \leq 5.0$ μs	For UI ≥ 50 μs, 220 ns < $t_R \leq 3.1$ μs For UI < 50 μs, 220 ns < $t_R \leq 2.1$ μs (within the transition region)
MARK (one, off)	More negative than –3.0 V	More negative than –3.3 V
Space (zero, on)	More positive than +3.0 V	More positive than +3.3 V
Short Circuit Proof ?	Yes, to any system voltage	Yes, to ground
Short Circuit Current	≤ 500 mA to any system voltage	≤ 60 mA to ground
Open Circuit Voltage	$|V_{OC}| \leq 25$ V	$|V_{OC}| < 13.2$ V
Loaded Output Voltage	5.0 V $\leq |V_O| \leq 15$ V for loads between 3.0 kΩ and 7.0 kΩ	$|V_O| \geq 3.7$ V for a load of 3.0 kΩ
Power Off Input Source Impedance	≥ 300 Ω for $|V_O| \leq 2.0$ V	≥ 300 Ω for $|V_O| \leq 2.0$ V

NOTE: UI = Unit Interval, or bit time.
V.28 standard has the same specifications as EIA–232, with the exception of transition time which is listed as "less than 1.0 ms, or 3% of the UI, whichever is less".
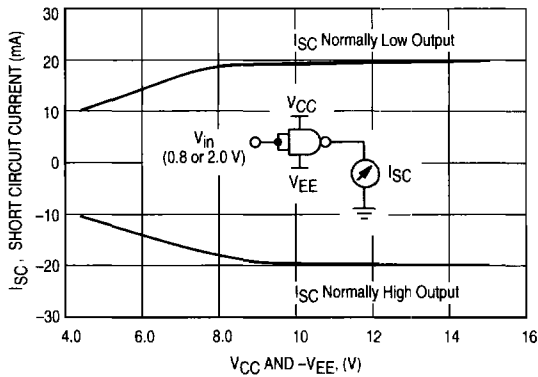

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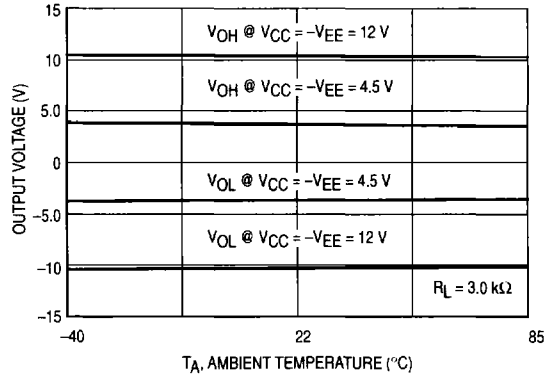### Figure 2. Typical Supply Current versus Supply Voltage
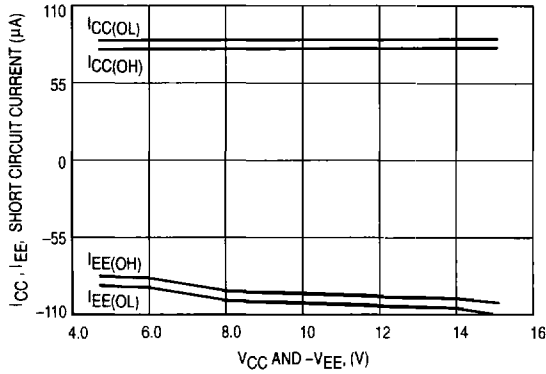
Figure 3. Typical Output Voltage versus Supply Voltage
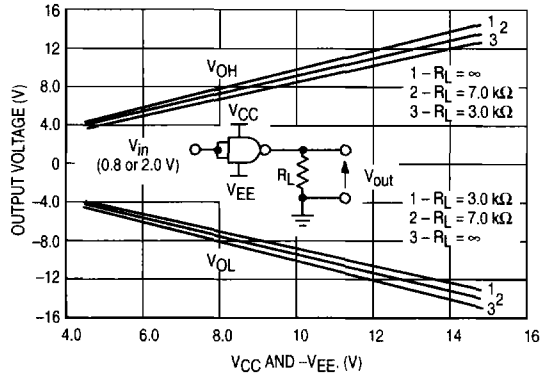
Figure 4. Typical Short Circuit Current versus Supply Voltage

Figure 5. Typical Output Voltage versus Temperature

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APPLICATIONS INFORMATION

Description

The MC14C88 was designed to be a direct replacement for the MC1488 in that it meets all EIA–232 specifications. However, use is extended as the MC14C88 also meets the faster EIA–562 and CCITT V.28 specifications. Slew rate limited outputs conform to the mentioned specifications and eliminate the need for external output capacitors. Low power consumption is made possible by BiMOS technology. Power supply current is limited to less than 160 μA, plus load currents over the supply voltage range of ±4.5 V to ±15 V (see Figure 2).

Outputs

The output low or high voltage depends on the state of the inputs, the load current, and the supply voltage (see Table 1 and Figure 3). The graphs apply to each driver regardless of how many other drivers within the package are supplying load current.

Table 1. Function Tables

Driver 1

Input A	Output A
H	L
L	H

Drivers 2 through 4

Input *1	Input *2	Output*
H	H	L
L	X	H
X	L	H

H = High level, L = Low level, X = Don't care.

Driver Inputs

The driver inputs determine the state of the outputs in accordance with Table 1. The nominal threshold voltage for the inputs is 1.4 Vdc, and for proper operation, the input voltages should be restricted to the range Gnd to V_{CC}. Should the input voltage drop below V_{EE} by more than 0.3 V or rise above V_{EE} by more than 39 V, excessive currents will flow at the input pin. Open input pins are equivalent to logic high, but good design practices dictate that inputs should never be left open.

Operating Temperature Range

The ambient operating temperature range is listed at –40° to +85°C and meets EIA–232–D, EIA–562 and CCITT V.28 specifications over this temperature range. The maximum ambient temperature is listed as +85°C. However, a lower ambient may be required depending on system use, i.e. specifically how many drivers within a package are used, and at what current levels they are operating. The maximum power which may be dissipated within the package is determined by:

$$P_{Dmax} = \frac{T_{Jmax} - T_A}{R_{\theta JA}}$$

where: $R_{\theta JA}$ = the package thermal resistance (typically, 100°C/W for the DIP package, 125°C/W for the SOIC package);

T_{Jmax} = the maximum operating junction temperature (150°C); and

T_A = the ambient temperature.

$P_D = \{ [(V_{CC} - V_{OH}) \times |I_{OH}|]$ or $[(V_{OL} - V_{EE}) \times |I_{OL}|] \}$ each driver $+ (V_{CC} \times I_{CC}) + (V_{EE} \times I_{EE})$

where: V_{CC} and V_{EE} are the positive and negative supply voltages;

V_{OH} and V_{OL} are measured or estimated from Figure 3;

I_{CC} and I_{EE} are the quiescent supply currents measured or estimated from Figure 2.

As indicated, the first term (in brackets) must be calculated and summed for each of the four drivers, while the last terms are common to the entire package.

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