National Semiconductor

DS89C21
Differential CMOS Line Driver and Receiver Pair

General Description

The DS89C21 is a differential CMOS line driver and receiver pair, designed to meet the requirements of TIA/EIA-422-A (RS-422) electrical characteristics interface standard. The DS89C21 provides one driver and one receiver in a minimum footprint. The device is offered in an 8-pin SOIC package.

The CMOS design minimizes the supply current to 6 mA, making the device ideal for use in battery powered or power conscious applications.

The driver features a fast transition time specified at 2.2 ns, and a maximum differential skew of 2 ns making the driver ideal for use in high speed applications operating above 10 MHz.

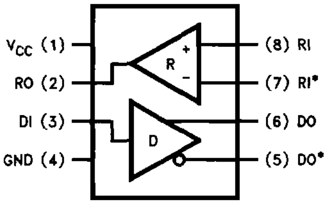
The receiver can detect signals as low as 200 mV, and also incorporates hysteresis for noise rejection. Skew is specified at 4 ns maximum.

The DS89C21 is compatible with TTL and CMOS levels (DI and RO).

Features

- Meets TIA/EIA-422-A (RS-422) and CCITT V.11 recommendation
- LOW POWER design—15 mW typical
- Guaranteed AC parameters:
  - — Maximum driver skew 2.0 ns
  - — Maximum receiver skew 4.0 ns
- Extended temperature range −40°C to +85°C
- Available in SOIC packaging
- Operates over 20 Mbps
- Receiver OPEN input failsafe feature

Connnection Diagram



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Order Number DS89C21TM or DS89C21TN
See NS Package Number M08A or N08E

Truth Tables

Driver

Input	Outputs	
DI	**DO**	**DO***
H	H	L
L	L	H

Receiver

Inputs	Output
RI-RI*	**RO**
$V_{DIFF} \geq +200$ mV	H
$V_{DIFF} \leq -200$ mV	L
OPEN†	H

†Non-terminated

Absolute Maximum Ratings (Note 1)

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

Supply Voltage (V_{CC})	7V
Driver Input Voltage (DI)	−1.5V to V_{CC} + 1.5V
Driver Output Voltage (DO, DO*)	−0.5V to +7V
Receiver Input Voltage—V_{CM} (RI, RI*)	±14V
Differential Receiver Input Voltage—V_{DIFF} (RI, RI*)	±14V
Receiver Output Voltage (RO)	−0.5V to V_{CC} +0.5V
Receiver Output Current (RO)	±25 mA
Storage Temperature Range (T_{STG})	−65°C to +150°C
Lead Temperature (T_L) (Soldering 4 sec.)	+260°C
Maximum Junction Temperature	150°C
Maximum Package Power Dissipation @ +25°C	
M Package	714 mW
N Package	1275 mW
Derate M Package	5.7 mW/°C above +25°C
Derate N Package	10.2 mW/°C above +25°C

Recommended Operating Conditions

	Min	Max	Units
Supply Voltage (V_{CC})	4.50	5.50	V
Operating Temperature (T_A)	−40	+85	°C
Input Rise or Fall Time (DI)		500	ns

Electrical Characteristics

Over recommended supply voltage and operating temperature ranges, unless otherwise specified. (Notes 2, 3)

Symbol	Parameter	Conditions		Pin	Min	Typ	Max	Units
DRIVER CHARACTERISTICS								
V_{IH}	Input Voltage HIGH			DI	2.0		V_{CC}	V
V_{IL}	Input Voltage LOW				GND		0.8	V
I_{IH}, I_{IL}	Input Current	V_{IN} = V_{CC}, GND, 2.0V, 0.8V				0.05	±10	μA
V_{CL}	Input Clamp Voltage	I_{IN} = −18 mA					−1.5	V
V_{OD1}	Unloaded Output Voltage	No Load		DO, DO*		4.2	6.0	V
V_{OD2}	Differential Output Voltage	R_L = 100Ω			2.0	3.0		V
ΔV_{OD2}	Change in Magnitude of V_{OD2} for Complementary Output States					5.0	400	mV
V_{OD3}	Differential Output Voltage	R_L = 150Ω			2.1	3.1		V
V_{OD4}	Differential Output Voltage	R_L = 3.9 kΩ				4.0	6.0	V
V_{OC}	Common Mode Voltage	R_L = 100Ω				2.0	3.0	V
ΔV_{OC}	Change in Magnitude of V_{OC} for Complementary Output States					2.0	400	mV
I_{OSD}	Output Short Circuit Current	V_{OUT} = 0V			−30	−115	−150	mA
I_{OFF}	Output Leakage Current	V_{CC} = 0V	V_{OUT} = +6V			0.03	+100	μA
			V_{OUT} = −0.25V			−0.08	−100	μA

Electrical Characteristics

Over recommended supply voltage and operating temperature ranges, unless otherwise specified. (Notes 2, 3) (Continued)

Symbol	Parameter	Conditions		Pin	Min	Typ	Max	Units
RECEIVER CHARACTERISTICS								
V_{TL}, V_{TH}	Differential Thresholds	V_{IN} = +7V, 0V, −7V		RI, RI*	−200	±25	+200	mV
V_{HYS}	Hysteresis	V_{CM} = 0V			20	50		mV
R_{IN}	Input Impedance	V_{IN} = −7V, +7V, Other = 0V			5.0	9.5		kΩ
I_{IN}	Input Current	Other Input = 0V, V_{CC} = 5.5V and V_{CC} = 0V	V_{IN} = +10V			+1.0	+1.5	mA
			V_{IN} = +3.0V		0	+0.22		mA
			V_{IN} = +0.5V			−0.04		mA
			V_{IN} = −3V		0	−0.41		mA
			V_{IN} = −10V			−1.25	−2.5	mA
V_{OH}	Output HIGH Voltage	I_{OH} = −6 mA	V_{DIFF} = +1V	RO	3.8	4.9		V
			V_{DIFF} = OPEN		3.8	4.9		V
V_{OL}	Output LOW Voltage	I_{OL} = +6 mA, V_{DIFF} = −1V				0.08	0.3	V
I_{OSR}	Output Short Circuit Current	V_{OUT} = 0V			−25	−85	−150	mA
DRIVER AND RECEIVER CHARACTERISTICS								
I_{CC}	Supply Current	No Load	DI = V_{CC} or GND	V_{CC}		3.0	6	mA
			DI = 2.4V or 0.5V			3.8	12	mA

Switching Characteristics

Over recommended supply voltage and operating temperature ranges, unless otherwise specified. (Note 3)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
DIFFERENTIAL DRIVER CHARACTERISTICS							
t_{PLHD}	Propagation Delay LOW to HIGH	R_L = 100Ω C_L = 50 pF	*(Figures 2, 3)*	2	4.9	10	ns
t_{PHLD}	Propagation Delay HIGH to LOW			2	4.5	10	ns
t_{SKD}	Skew, $\lvert t_{PLHD}-t_{PHLD} \rvert$				0.4	2.0	ns
t_{TLH}	Transition Time LOW to HIGH		*(Figures 2, 4)*		2.2	9	ns
t_{THL}	Transition Time HIGH to LOW				2.1	9	ns
RECEIVER CHARACTERISTICS							
t_{PLH}	Propagation Delay LOW to HIGH	C_L = 50 pF V_{DIFF} = 2.5V V_{CM} = 0V	*(Figures 5, 6)*	6	18	30	ns
t_{PHL}	Propagation Delay HIGH to LOW			6	17.5	30	ns
t_{SK}	Skew, $\lvert t_{PLH}-t_{PHL} \rvert$				0.5	4.0	ns
t_r	Rise Time		*(Figure 7)*		2.5	9	ns
t_f	Fall Time				2.1	9	ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Electrical Characteristics" specify conditions for device operation.

Note 2: Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground unless otherwise specified.

Note 3: All typicals are given for V_{CC} = 5.0V and T_A = 25°C.

Note 4: f = 1 MHz, t_r and $t_f \leq$ 6 ns.

Note 5: ESD Rating: HBM (1.5 kΩ, 100 pF) all pins ≥ 2000V.
EIAJ (0Ω, 200 pF) ≥ 250V

Parameter Measurement Information

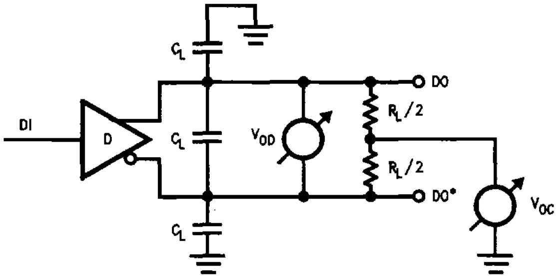

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FIGURE 1. V_{OD} and V_{OC} Test Circuit

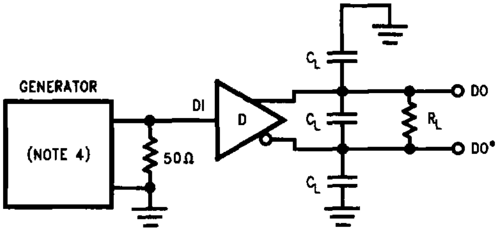

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FIGURE 2. Driver Propagation Delay Test Circuit

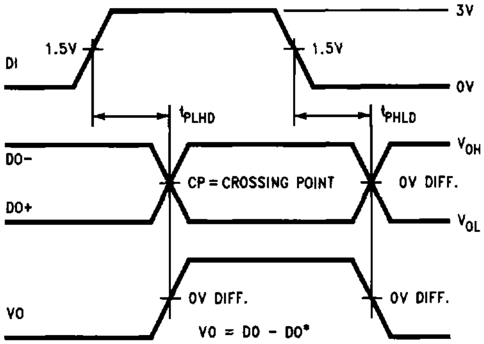

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FIGURE 3. Driver Differential Propagation Delay Timing

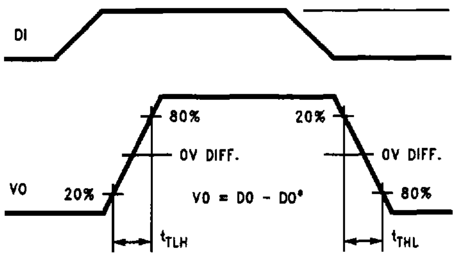

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FIGURE 4. Driver Differential Transition Timing

Parameter Measurement Information (Continued)

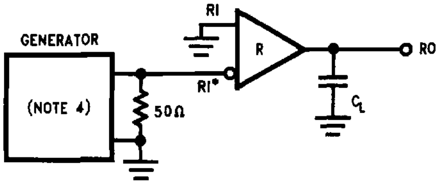

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FIGURE 5. Receiver Propagation Delay Test Circuit

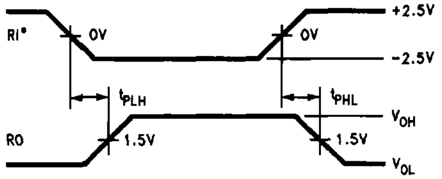

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FIGURE 6. Receiver Propagation Delay Timing

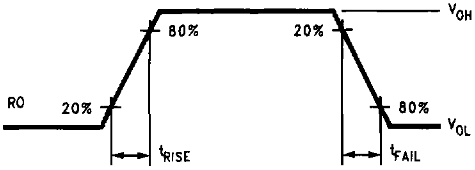

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FIGURE 7. Receiver Rise and Fall Times