National Semiconductor

May 1998

DS14C241
Single Supply TIA/EIA-232 4 x 5 Driver/Receiver

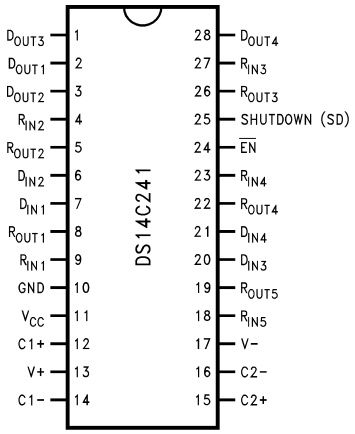
General Description

The DS14C241 is four driver, five receiver device which conforms to the TIA/EIA-232-E standard and CCITT V.28 recommendations. This device eliminates ±12V supplies by employing an internal DC–DC converter to generate the necessary output levels from a single +5V supply. Driver slew rate control and receiver noise filtering have also been internalized to eliminate the need for external slew rate control and noise filtering capacitors. With the addition of TRI-STATE®receiver outputs and a shutdown mode, device power consumption is kept to a minimum.

Features

- Conforms to TIA/EIA-232-E and CCITT V.28
- Internal DC–DC converter
- Operates with single +5V supply
- Low power requirement — I_{CC} 10 mA max
- Shutdown mode — I_{CX} 10 µA max
- Internal driver slew rate control
- Receiver noise filtering
- Operates above 120 kbits/sec
- TRI-STATE receiver outputs
- Direct replacement for MAX241

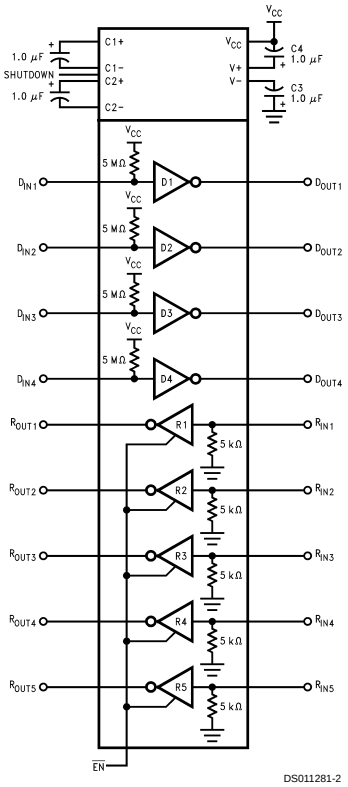
Connection Diagram



DS011281-1

Order Number DS14C241WM
See NS Package Number M28B

Functional Diagram



DS011281-2

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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.

Supply Voltage (V_{CC})	−0.3V to +6V
V^+ Pin	(V_{CC} − 0.3V) to +15V
V^- Pin	+0.3V to −15V
Driver Input Voltage	−0.3V to (V_{CC} + 0.3V)
Driver Output Voltage	(V^+ + 0.3V) to (V^- − 0.3V)
Receiver Input Voltage	±30V
Receiver Output Voltage	−0.3V to (V_{CC} + 0.3V)
Junction Temperature	+150˚C
Maximum Package Power Dissipation @ +25˚C (Note 6)	
WM Package	1520 mW
Storage Temperature Range	−65˚C to +150˚C
Lead Temperature (Soldering, 4 sec.)	+260˚C
Short Circuit Duration (D_{OUT})	continuous
ESD Rating (HBM, 1.5 kΩ, 100 pF)	≥ 2.0 kV

Recommended Operating Conditions

	Min	Max	Units
Supply Voltage (V_{CC})	4.5	5.5	V
Operating Free Air Temp. (T_A)			
DS14C241	0	+70	˚C

Electrical Characteristics (Note 2)

Over recommended operating conditions, unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ	Max	Units
DEVICE CHARACTERISTICS							
V^+	Positive Power Supply	R_L = 3 kΩ, C1–C4 = 1.0 µF, D_{IN} = 0.8V			9.0		V
V^-	Negative Power Supply	R_L = 3 kΩ, C1–C4 = 1.0 µF, D_{IN} = 2.0V			−8.0		V
I_{CC}	Supply Current (V_{CC})	No Load			8.5	10	mA
I_{CX}	Supply Current Shutdown	R_L = 3 kΩ, SD = V_{CC}			1.0	10	µA
V_{IH}	High Level Enable Voltage		SD	2.4		V_{CC}	V
V_{IL}	Low Level Enable Voltage			GND		0.8	V
I_{IH}	High Level Enable Current			−10		+10	µA
I_{IL}	Low Level Enable Current			−10		+10	µA
DRIVER CHARACTERISTICS							
V_{IH}	High Level Input Voltage		D_{IN}	2.0		V_{CC}	V
V_{IL}	Low Level Input Voltage			GND		0.8	V
I_{IH}	High Level Input Current	$V_{IN} \geq 2.0V$		−10		+10	µA
I_{IL}	Low Level Input Current	$V_{IN} \leq 0.8V$		−10		+10	µA
V_{OH}	High Level Output Voltage	R_L = 3 kΩ		5.0	7.5		V
V_{OL}	Low Level Output Voltage				−6.5	−5.0	V
$I_{OS}+$	Output High Short Circuit Current	V_O = 0V, V_{IN} = 0.8V		−30	−15	−5.0	mA
$I_{OS}-$	Output Low Short Circuit Current	V_O = 0V, V_{IN} = 2.0V		5.0	12	30	mA
R_O	Output Resistance	$-2V \leq V_O \leq +2V$, V_{CC} = GND = 0V		300			Ω
RECEIVER CHARACTERISTICS							
V_{TH}	Input High Threshold Voltage				1.9	2.4	V
V_{TL}	Input Low Threshold Voltage			0.8	1.5		V
V_{HY}	Hysteresis			0.2	0.4	1.0	V
R_{IN}	Input Resistance			3.0	4.5	7.0	kΩ
I_{IN}	Input Current	V_{IN} = +15V		2.14	3.8	5.0	mA
		V_{IN} = +3V		0.43	0.6	1.0	mA
		V_{IN} = −3V		−1.0	−0.6	−0.43	mA
		V_{IN} = −15V		−5.0	−3.8	−2.14	mA
V_{OH}	High Level Output Voltage	V_{IN} = −3V, I_O = −3.2 mA		3.5	4.6		V
		V_{IN} = −3V, I_O = −20 µA		4.0	4.9		V
V_{OL}	Low Level Output Voltage	V_{IN} = +3V, I_O = +2.0 mA			0.25	0.4	V

Electrical Characteristics (Note 2) (Continued)

Over recommended operating conditions, unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ	Max	Units
RECEIVER CHARACTERISTICS							
V_{IH}	High Level Input Voltage		$\overline{EN}$	2.0		V_{CC}	V
V_{IL}	Low Level Input Voltage			GND		0.8	V
I_{IH}	High Level Input Current	$V_{IN} \geq 2.0V$		−10		+10	µA
I_{IL}	Low Level Input Current	$V_{IN} \leq 0.8V$		−10		+10	µA
I_{OZ}	Output Leakage Current	$\overline{EN} = V_{CC}$, $0V \leq R_{OUT} \leq V_{CC}$		−10		+10	µA

Switching Characteristics (Note 4)

Over recommended operating conditions, unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ	Max	Units
DRIVER CHARACTERISTICS							
t_{PLH}	Propagation Delay LOW to HIGH	R_L = 3 kΩ			0.7	4.0	µs
t_{PHL}	Propagation Delay HIGH to LOW	C_L = 50 pF			0.6	4.0	µs
t_{SK}	Skew $\lvert t_{PLH} - t_{PHL} \rvert$	(*Figures 1, 2*)			0.1	1.0	µs
SR1	Output Slew Rate	R_L = 3 kΩ to 7 kΩ, C_L = 50 pF		4.0	15	30	V/µs
SR2	Output Slew Rate	R_L = 3 kΩ, C_L = 2500 pF		3.0	5.0		V/µs
RECEIVER CHARACTERISTICS							
t_{PLH}	Propagation Delay LOW to HIGH	Input Pulse Width > 10 µs			2.0	6.5	µs
t_{PHL}	Propagation Delay HIGH to LOW	C_L = 50 pF			2.8	6.5	µs
t_{SK}	Skew $\lvert t_{PLH} - t_{PHL} \rvert$	(*Figures 3, 4*)			0.8	2.0	µs
t_{PLZ}		(*Figures 5, 7*)			0.1	2.0	µs
t_{PZL}					0.6	2.0	µs
t_{PHZ}		(*Figures 5, 6*)			0.2	2.0	µs
t_{PZH}					0.6	2.0	µs
t_{NW}	Noise Pulse Width Rejected	(*Figures 3, 4*)			2.5	1.0	µs

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: I_{OS}+ and I_{OS}− values are for one output at a time. If more than one output is shorted simultaneously, the device power dissipation may be exceeded.

Note 4: Receiver AC input waveform for test purposes: $t_r = t_f$ = 200 ns, V_{IH} = 3V, V_{IL} = −3V, f = 64 kHz (128 kbits/sec). Driver AC input waveform for test purposes: $t_r = t_f \leq 10$ ns, V_{IH} = 3V, V_{IL} = 0V, f = 64 kHz (128 kbits/sec).

Note 5: All typicals are given for V_{CC} = 5.0V and T_A = +25°C.

Note 6: Ratings apply to ambient temperature at +25°C. Above this temperature derate: WM package 14.3 mW/°C.

Parameter Measurement Information

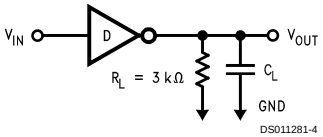


FIGURE 1. Driver Load Circuit

Parameter Measurement Information (Continued)

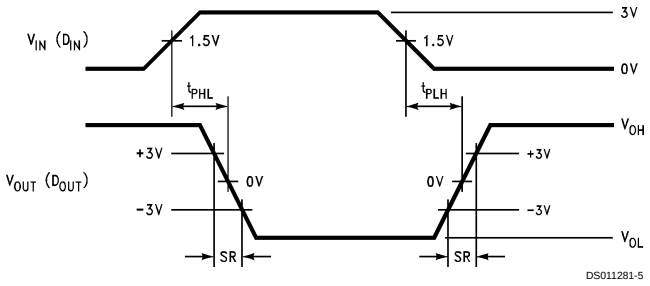


FIGURE 2. Driver Switching Waveform

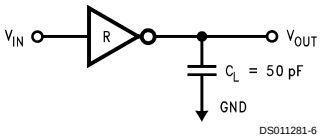


FIGURE 3. Receiver Load Circuit

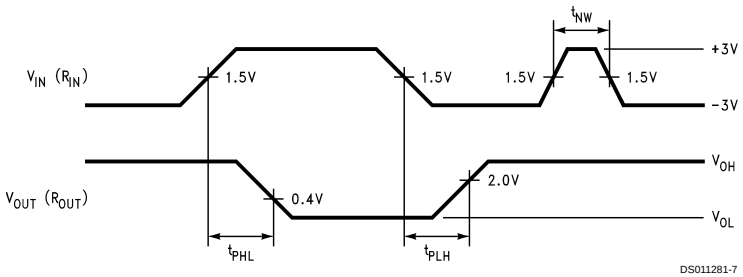


FIGURE 4. Receiver Propagation Delays and Noise Rejection

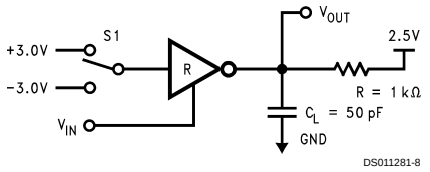


FIGURE 5. Receiver Disable Load Circuit

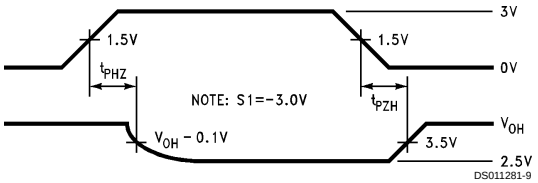


FIGURE 6. Receiver TRI-STATE Timing (t_{PHZ}, t_{PZH})

Parameter Measurement Information (Continued)

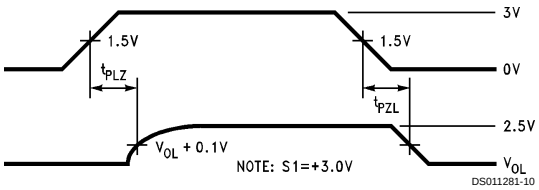


FIGURE 7. Receiver TRI-STATE Timing (t_{PLZ}, t_{PZL})

Pin Descriptions

V_{CC} (pin 11) — Power supply pin for the device, +5V (±10%).

V^+ (pin 13) — Positive supply for TIA/EIA-232-E drivers. Recommended external capacitor: C4 = 1.0 µF (6.3V). This supply is not intended to be loaded externally.

V^- (pin 17) — Negative supply for TIA/EIA-232-E drivers. Recommended external capacitor: C3 = 1.0 µF (16V). This supply is not intended to be loaded externally.

$C1^+$, $C1^-$ (pins 12 and 14) — External capacitor connection pins. Recommended capacitor — 1.0 µF (6.3V).

$C2^+$, $C2^-$ (pins 15 and 16) — External capacitor connection pins. Recommended capacitor — 1.0 µF (16V).

$\overline{EN}$ (pin 24) — Controls the Receiver output TRI-STATE Circuit. A HIGH level on this pin will disable the Receiver Output.

SHUTDOWN (SD) (pin 25) — A High on the SHUTDOWN pin will lower the total I_{CC} current to less than 10 µA. Providing a low power state.

D_{IN} 1–4 (pins 7, 6, 20 and 21) — Driver input pins are TTL/CMOS compatible. Inputs of unused drivers may be left open, an internal pull-up resistor (500 kΩ minimum, typically 5 MΩ) pulls input to V_{CC}. Output will be LOW for open inputs.

D_{OUT} 1–4 (pins 2, 3, 1 and 28) — Driver output pins conform to TIA/EIA-232-E levels.

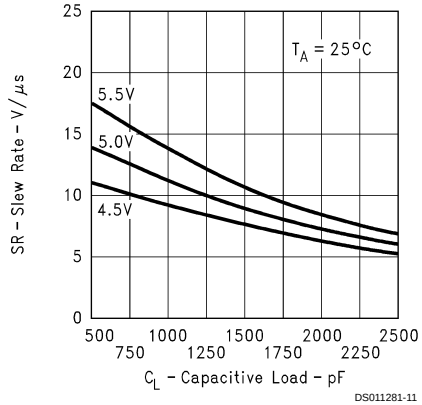
R_{IN} 1–5 (pins 9, 4, 27, 23 and 18) — Receiver input pins accept TIA/EIA-232-E input voltages (±15V). Receivers feature a noise filter and guaranteed hysteresis of 200 mV. Unused receiver input pins may be left open. Internal input resistor (5 kΩ) pulls input LOW, providing a failsafe HIGH output.

R_{OUT} 1–5 (pins 8, 5, 26, 22 and 19) — Receiver output pins are TTL/CMOS compatible. Receiver output HIGH voltage is specified for both CMOS and TTL load conditions.

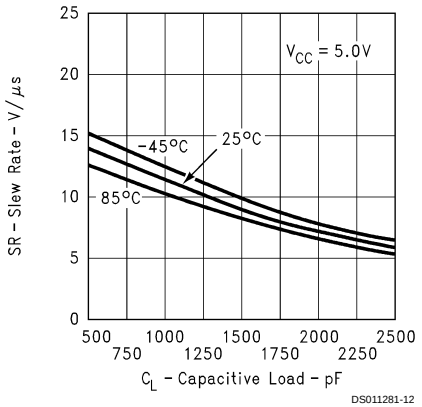
GND (pin 10) — Ground pin.

Typical Performance Characteristics

Slew Rate vs Cap. Load vs V_{CC} (Four Drivers)

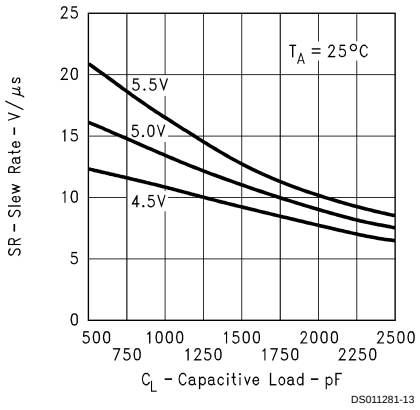


Slew Rate vs Temperature vs Cap. Load (Four Drivers Switching)

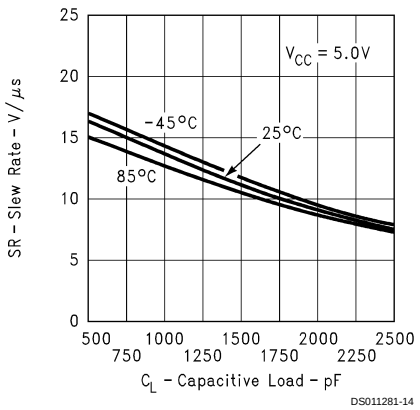


Typical Performance Characteristics (Continued)

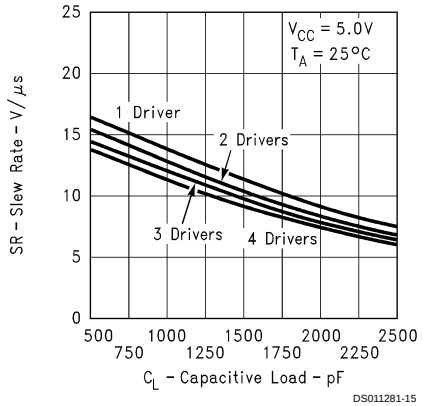
Slew Rate vs Cap. Load vs V_{CC} (One Driver)



Slew Rate vs Temperature vs Cap. Load (One Driver Switching)



Driver Slew Rate vs Cap. Load vs Number of Drivers



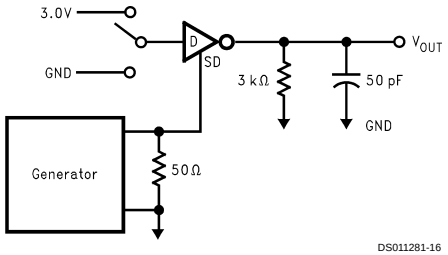


FIGURE 8. Driver Shutdown (SD) Delay Test Circuit

Typical Performance Characteristics (Continued)

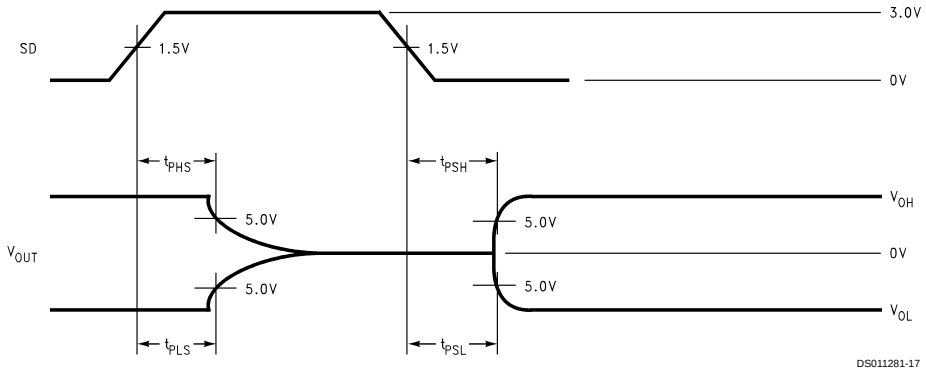


FIGURE 9. Driver Shutdown (SD) Delay Timing Waveforms

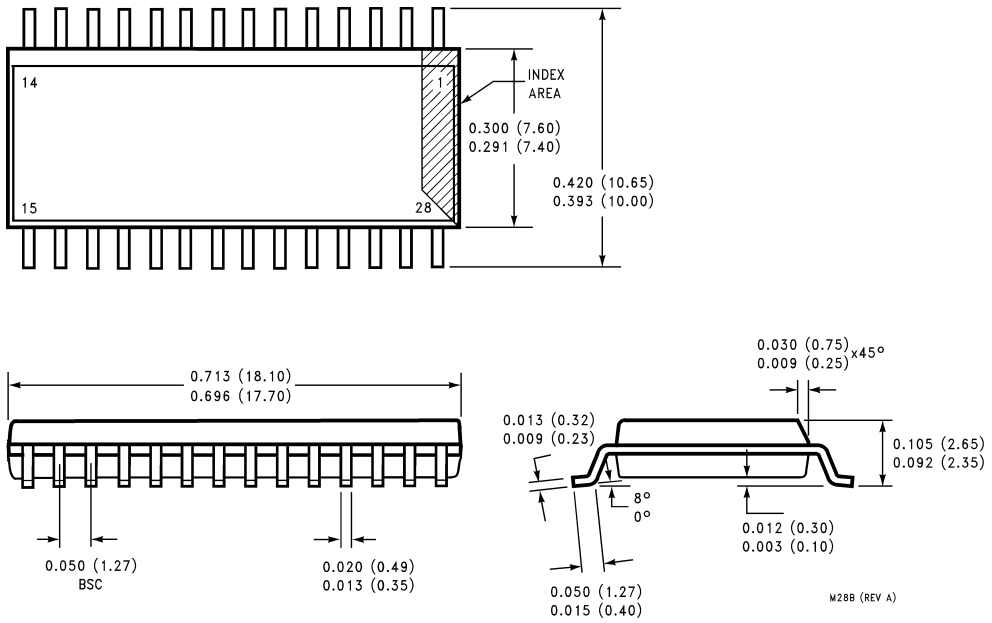
Typical data only.

Symbol	Parameter	Conditions	Typ	Units
t_{PHS}	Propagation Delay High to SD	V_{CC} = 5V (Notes 7, 8)	124	µs
t_{PLS}	Propagation Delay Low to SD	T_A = 25˚C	110	µs
t_{PSH}	Propagation Delay SD to High		114	µs
t_{PSL}	Propagation Delay SD to Low		97	µs

Note 7: Sample size = 10 parts; 3 different datecodes.

Note 8: All drivers are loaded as shown in *Figure 8* .

Physical Dimensions inches (millimeters) unless otherwise noted



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NS Package Number M28B

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