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# DS14C535

## + 5V Supply EIA/TIA-232 3 x 5 Driver/Receiver

### General Description

The DS14C535 is three driver, five receiver device which conforms to EIA/TIA-232-E and CCITT (ITU-T) V.28 standard specifications. This device employs an internal DC-DC converter to generate the necessary output levels from a +5V power supply. A SHUTDOWN (SD) mode reduces the supply current to 10  $\mu$ A maximum. In the SD mode, one receiver is active, allowing ring indicator (RI) to be monitored. PC Board space consumption is minimized by the availability of Shrink Small Outline Packaging (SSOP).

The DS14C535 provides a one-chip solution for the common 9-pin serial RS-232 interface between data terminal and data circuit-terminating equipment.

This device allows an easy migration path to the 3.3V DS14C335. The packages are the same. The N/C pins on the DS14C535 are not physically connected to the chip. Board layout for the DS14C335 will accommodate both devices.

This device's low power requirement and small footprint makes it an ideal choice for Laptop and Notebook applications.

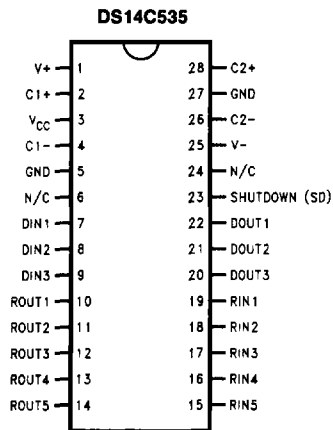
### Features

- Pin compatible with DS14C335
- Conforms to EIA/TIA-232-E and CCITT (ITU-T) V.28 specifications
- Failsafe receiver outputs high when inputs open
- Operates with single +5V power supply
- Low power requirement— $I_{CC}$  12 mA maximum
- SHUTDOWN mode— $I_{CX}$  10  $\mu$ A maximum
- One Receiver (R5) active during SHUTDOWN
- Operates up to 128 kbps—Lap-Link® Compatible
- 4V/ $\mu$ s minimum Slew Rate guaranteed
- ESD rating of 3 kV on all pins (H, B, M)
- Available in 28-lead SSOP EIAJ Type II package
- Only four 0.1  $\mu$ F capacitors required for the DC-DC converter

**2**

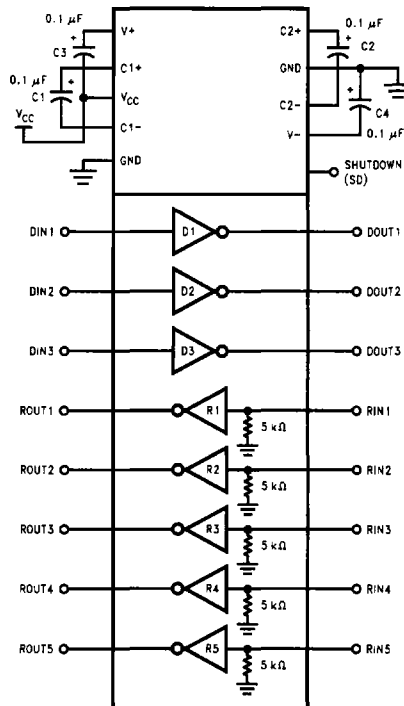
### Connection Diagram

### Functional Diagram



TL/F/11910-1

Order Number **DS14C535MSA** or  
**DS14C535TMSA**  
 See NS Package Number **MSA28**



TL/F/11910-2

**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 +14V
$V^-$ Pin	+0.3V to -14V
Input Voltage ( $D_{IN}$ , SD)	-0.3V to +5.5V
Driver Output Voltage	( $V^+ + 0.3V$ ) to ( $V^- - 0.3V$ )
Receiver Input Voltage	$\pm 25V$
Receiver Output Voltage	-0.3V to ( $V_{CC} + 0.3V$ )
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering 4 sec.)	+260°C
Short Circuit Duration ( $D_{OUT}$ )	Continuous
Maximum Package Power Dissipation @ +25°C	
SSOP MSA Package	1286 mW
Derate MSA Package 10.3 mW/°C above +25°C	
ESD Rating (HBM, 1.5 k $\Omega$ , 100 pF)	$\geq 3.0$ kV

**Recommended Operating Conditions**

	Min	Max	Units
Supply Voltage ( $V_{CC}$ )	4.5	5.5	V
Operating Free Air Temperature ( $T_A$ )			
DS14C535	0	+70	°C

DC-DC Converter Capacitors (C1-C4)

Recommended range of values is 0.1  $\mu F$  to 0.68  $\mu F$ ,  $\pm 20\%$ . For more detail refer to application information section of this data sheet.

**Electrical Characteristics**

Over recommended operating conditions. SD = 0.8V, unless otherwise specified. (Notes 2, 3)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>DEVICE CHARACTERISTICS</b>						
$V^+$	Positive Power Supply	No Load		+8.5		V
$V^-$	Negative Power Supply	C1-C4 = 0.1 $\mu F$	$D_{IN} = 0.8V$			V
			$D_{IN} = 2.0V$	-7.0		V
$I_{CC}$	Supply Current	No Load			12	mA
$I_{CX}$	SHUTDOWN Supply Current	$R_L = 3$ k $\Omega$ , SD = $V_{CC}$		1.0	10	$\mu A$
$V_{IH}$	High Level Enable Voltage		SD	2.0		V
$V_{IL}$	Low Level Enable Voltage			GND	0.8	V
$I_{IH}$	High Level Enable Current	$2.0V \leq V_{IN} \leq 5.5V$			+2.0	$\mu A$
$I_{IL}$	Low Level Enable Current	$GND \leq V_{IN} \leq 0.8V$		-2.0		$\mu A$
<b>DRIVER CHARACTERISTICS</b>						
$V_{IH}$	High Level Input Voltage		$D_{IN}$	2.0		V
$V_{IL}$	Low Level Input Voltage			GND	0.8	V
$I_{IH}$	High Level Input Current	$2.0V \leq V_{IN} \leq 5.5V$			+1.0	$\mu A$
$I_{IL}$	Low Level Input Current	$GND \leq V_{IN} \leq 0.8V$		-1.0		$\mu A$
$V_{OH}$	High Level Output Voltage	$R_L = 3$ k $\Omega$		+5.0	8	V
$V_{OL}$	Low Level Output Voltage			-6.7	-5.0	V
$I_{OS+}$	Output High Short Circuit Current	$V_O = 0V$ , $V_{IN} = 0.8V$ (Note 7)		-40	-20	mA
$I_{OS-}$	Output Low Short Circuit Current	$V_O = 0V$ , $V_{IN} = 2.0V$ (Note 7)		6	15	mA
$R_O$	Output Resistance	$-2V \leq V_O \leq +2V$ , $V_{CC} = GND = 0V$		300	1200	$\Omega$

**Electrical Characteristics** (Continued)

Over recommended operating conditions, SD = 0.8V, unless otherwise specified. (Notes 2, 3)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>RECEIVER CHARACTERISTICS</b> (Note 4)						
V <sub>TH</sub>	Input High Threshold Voltage	R1–R5, SD = 0.8V (Active Mode)		1.4	2.4	V
		R5, 2.0V ≤ SD ≤ 5.5V (Shutdown Mode)		2.0	2.8	V
V <sub>TL</sub>	Input Low Threshold Voltage	R1–R5, SD = 0.8V (Active Mode)	0.8	1.1		V
		R5, 2.0V ≤ SD ≤ 5.5V (Shutdown Mode)	0.8	1.1		V
V <sub>HY</sub>	Hysteresis (Note 4)		0.15		1.0	V
R <sub>IN</sub>	Input Resistance	V <sub>IN</sub> = ±3V to ±15V	3.0	5.4	7.0	kΩ
I <sub>IN</sub>	Input Current	V <sub>IN</sub> = +15V	2.14		5.0	mA
		V <sub>IN</sub> = +3V	0.43		1.0	mA
		V <sub>IN</sub> = –3V	–1.0		–0.43	mA
		V <sub>IN</sub> = –15V	–5.0		–2.14	mA
V <sub>OH</sub>	High Level Output Voltage	V <sub>IN</sub> = –3V, I <sub>OH</sub> = –2.0 mA	3.8			V
		V <sub>IN</sub> = –3V, I <sub>OH</sub> = –20 μA	4.0			V
V <sub>OL</sub>	Low Level Output Voltage	V <sub>IN</sub> = +3V, I <sub>OL</sub> = +2.0 mA		0.23	0.4	V

## Switching Characteristics

Over recommended operating conditions, SD = 0.8V, unless otherwise specified. (Note 4)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>DRIVER CHARACTERISTICS</b>						
$t_{PLH}$	Propagation Delay LOW to HIGH	$R_L = 3\text{ k}\Omega$ $C_L = 50\text{ pF}$ (Figures 1 and 2)	0.1	0.6	1.0	$\mu\text{s}$
$t_{PHL}$	Propagation Delay HIGH to LOW		0.1	0.6	1.0	$\mu\text{s}$
$t_{SK}$	Skew $ t_{PLH} - t_{PHL} $			0	0.2	$\mu\text{s}$
SR1	Output Slew Rate	$R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$ , $C_L = 50\text{ pF}$ (Figure 2)	4	13	30	$\text{V}/\mu\text{s}$
SR2	Output Slew Rate	$R_L = 3\text{ k}\Omega$ , $C_L = 2500\text{ pF}$ (Figure 2)	4	10	30	$\text{V}/\mu\text{s}$
$t_{PLS}$	Propagation Delay LOW to SD	$R_L = 3\text{ k}\Omega$ $C_L = 50\text{ pF}$ (Figures 5 and 6)		0.48		ms
$t_{PSL}$	Propagation Delay SD to LOW			1.88		ms
$t_{PHS}$	Propagation Delay HIGH to SD			0.62		ms
$t_{PSH}$	Propagation Delay SD to HIGH			1.03		ms
<b>RECEIVER CHARACTERISTICS</b>						
$t_{PLH}$	Propagation Delay LOW to HIGH	$C_L = 50\text{ pF}$ (Figures 3 and 4)	0.1	0.4	1.0	$\mu\text{s}$
$t_{PHL}$	Propagation Delay HIGH to LOW		0.1	0.6	1.0	$\mu\text{s}$
$t_{SK}$	Skew $ t_{PLH} - t_{PHL} $			0.1	0.5	$\mu\text{s}$
$t_{PLS}$	Propagation Delay LOW to SD	$R_L = 1\text{ k}\Omega$ $C_L = 50\text{ pF}$ $R1 - R4$ Only (Figures 7 and 8)		0.13		$\mu\text{s}$
$t_{PSL}$	Propagation Delay SD to LOW			1.0		$\mu\text{s}$
$t_{PHS}$	Propagation Delay HIGH to SD			0.19		$\mu\text{s}$
$t_{PSH}$	Propagation Delay SD to HIGH			0.58		$\mu\text{s}$

**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:** Typical values are given for  $V_{CC} = 5\text{V}$  and  $T_A = +25^\circ\text{C}$ .

**Note 3:** 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. For voltage logic levels, the more positive value is designated as maximum. For example, if  $-5\text{V}$  is a maximum, the typical value ( $-6.7\text{V}$ ) is more negative.

**Note 4:** Receiver characteristics are guaranteed for SD = 0.8V. When SD = 2.0V, receiver five (R5) is active and meets receiver parameters in SHUTDOWN (SD) mode, unless otherwise specified.

**Note 5:** Generator characteristics for driver input:  $f = 64\text{ kHz}$  (128 kbits/sec),  $t_r = t_f < 10\text{ ns}$ ,  $V_{IH} = 3\text{V}$ ,  $V_{IL} = 0\text{V}$ , duty cycle = 50%.

**Note 6:** Generator characteristics for receiver input:  $f = 64\text{ kHz}$  (128 kbits/sec),  $t_r = t_f < 10\text{ ns}$ ,  $V_{IH} = 3\text{V}$ ,  $V_{IL} = -3\text{V}$ , duty cycle = 50%.

**Note 7:** Only one driver output shorted at a time.

# Parameter Measurement Information

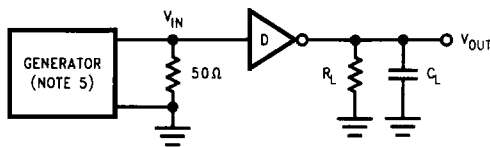


FIGURE 1. Driver Propagation Delay and Slew Rate Test Circuit TL/F/11910-3

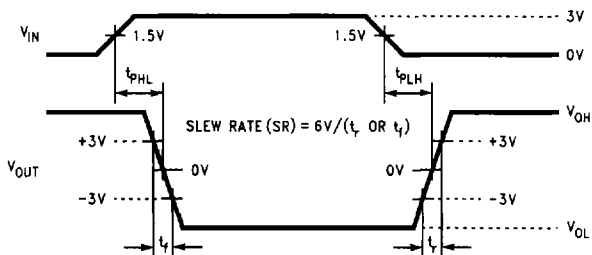


FIGURE 2. Driver Propagation Delay and Slew Rate Timing TL/F/11910-4

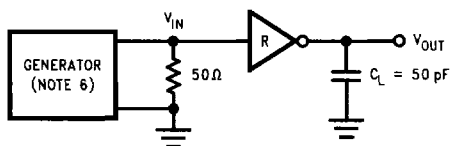


FIGURE 3. Receiver Propagation Delay Test Circuit TL/F/11910-5

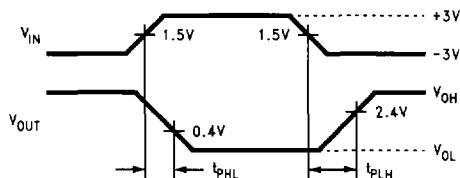


FIGURE 4. Receiver Propagation Delay Timing TL/F/11910-6

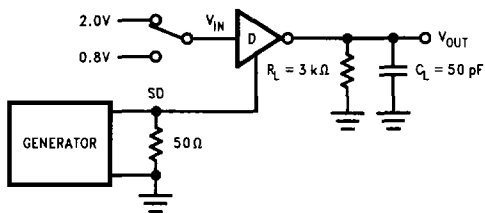


FIGURE 5. Driver SHUTDOWN (SD) Delay Test Circuit TL/F/11910-7

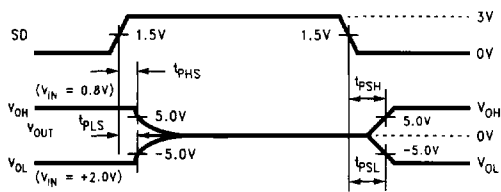


FIGURE 6. Driver SHUTDOWN (SD) Delay Timing TL/F/11910-8

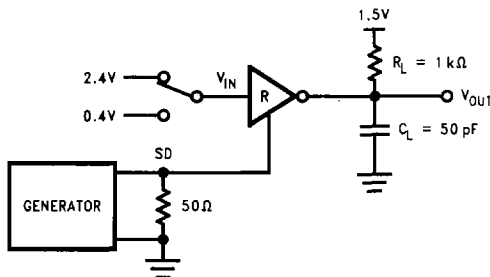
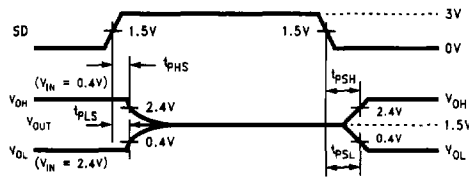


FIGURE 7. Receiver SHUTDOWN (SD) Delay Test Circuit TL/F/11910-9

## Parameter Measurement Information (Continued)



TL/F/11910-10

FIGURE 8. Receiver SHUTDOWN (SD) Delay Timing

## Pin Descriptions

**V<sub>CC</sub> (Pin 3).** Power supply pin for the device, +5V (±0.5V).

**V<sup>+</sup> (Pin 1).** Positive supply for EIA/TIA-232-E drivers. Recommended external capacitor—0.1 μF (16V). This supply is not intended to be loaded externally.

**V<sup>-</sup> (Pin 25).** Negative supply for EIA/TIA-232-E drivers. Recommended external capacitor—0.1 μF (16V). This supply is not intended to be loaded externally.

**C1+, C1- (Pins 2, 4).** External capacitor connection pins.

**C2+, C2- (Pins 28, 26).** External capacitor connection pins.

**SHUTDOWN (SD) (Pin 23).** A High on the SHUTDOWN pin will lower the total I<sub>CC</sub> current to less than 10 μA, providing a low power state. In this mode receiver R5 does not

main active. The SD pin should be driven or tied low (GND) to disable the shutdown mode.

**DIN 1-3 (Pins 7, 8, 9).** Driver input pins.

**DOUT 1-3 (Pins 22, 21, 20).** Driver output pins conform to EIA/TIA-232 -E levels.

**RIN 1-5 (Pins 19, 18, 17, 16, 15).** Receiver input pins accept EIA/TIA-232-E input voltages (±2.5V). Receivers guarantee hysteresis of TBD mV. Unused receiver input pins may be left open. Internal input resistor (5 kΩ) pulls input LOW, providing a failsafe HIGH output.

**ROUT 1-5 (Pins 10, 11, 12, 13, 14).** Receiver output pins.

**GND (Pins 5, 27).** Ground Pins. Both pins must be connected to external ground. These pins are not connected together on the chip.

## Application Information

In a typical Data Terminal Equipment (DTE) to Data Circuit-Terminating Equipment (DCE) 9-pin de-facto interface implementation, 2 data lines and 6 control lines are required. The data lines are TXD and RXD and the control lines are RTS, DTR, DSR, DCD, CTS and RI. The DS14C535 is a 3 x 5 Driver/Receiver and offers a single chip solution for the DTE interface as shown in Figure 9.

Ring Indicator (RI) is used to inform the DTE that an incoming call is coming from a remote DCE. When the DS14C535 is in SHUTDOWN (SD) mode, receiver five (R5) remains active and monitors RI circuit. This active receiver (R5) alerts the DTE to switch the DS14C535 from SHUTDOWN to active mode.

To achieve minimum power consumption, the DS14C535 can be in SHUTDOWN mode and only activated when communications are needed.

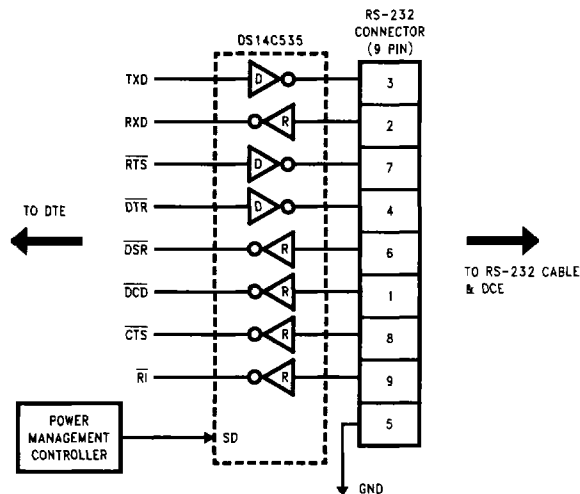


FIGURE 9. Typical DTE Application

TL/F/11910-11

**Application Information** (Continued)

## Capacitors:

Capacitors can be ceramic or tantalum. Standard surface mount in the range of 0.1  $\mu$ F to 0.68  $\mu$ F are readily available from several manufacturers. A minimum 20V rating is recommended. Contact manufacturers for specific detail on surface mounting and dielectrics. A partial list of manufacturers include:

Manufacturer	Phone Number
KEMET	803-963-6300
AVX	803-448-9411
MURATA-ERIE	800-831-9172