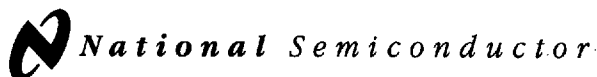


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## DS14C232

### Low Power +5V Powered TIA/EIA-232 Dual Driver/Receiver

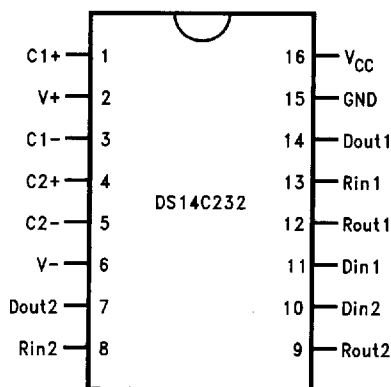
#### General Description

The DS14C232 is a low power dual driver/receiver featuring an onboard DC to DC converter, eliminating the need for  $\pm 12V$  power supplies. The device only requires a +5V power supply.  $I_{CC}$  is specified at 3.0 mA maximum, making the device ideal for battery and power conscious applications. The drivers' slew rate is set internally and the receivers feature internal noise filtering, eliminating the need for external slew rate and filter capacitors. The device is designed to interface data terminal equipment (DTE) with data circuit-terminating equipment (DCE). The driver inputs and receiver outputs are TTL and CMOS compatible. DS14C232C driver outputs and receiver inputs meet TIA/EIA-232-E (RS-232) and CCITT V.28 standards.

#### Features

- Pin compatible with industry standard MAX232, LT1081, ICL232 and TSC232
- Single +5V power supply
- Low power— $I_{CC}$  3.0 mA maximum
- DS14C232C meets TIA/EIA-232-E (RS-232) and CCITT V.28 standards
- CMOS technology
- Receiver Noise Filter
- Package efficiency—2 drivers and 2 receivers
- Available in Plastic DIP, Narrow and Wide SOIC packages
- TIA/EIA-232 compatible extended temperature range options:
  - DS14C232T -40°C to +85°C
  - DS14C232 -55°C to +125°C

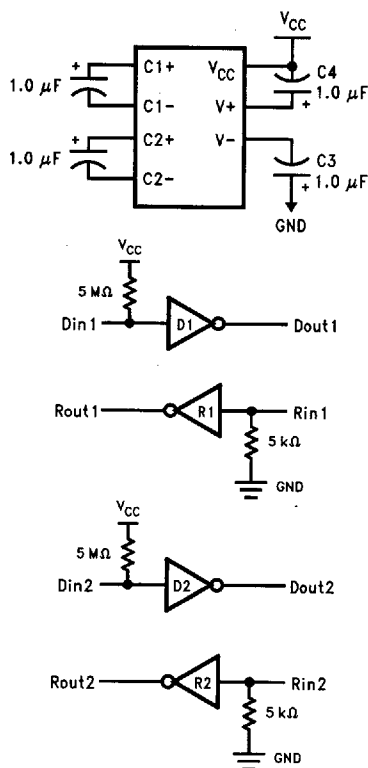
#### Connection Diagrams



TL/F/10744-1

Order Number DS14C232CN, DS14C232TN,  
DS14C232CM, DS14C232TM,  
DS14C232CWM or DS14C232TWM  
See NS Package Number N16A, M16A or M16B

#### Functional Diagram



TL/F/10744-2

## COMMERCIAL

## Absolute Maximum Ratings (Note 1)

Specifications for the 883 version of this product are listed separately on the following pages.

|                                                   |                                   |
|---------------------------------------------------|-----------------------------------|
| Supply Voltage, $V_{CC}$                          | -0.3V to 6V                       |
| $V^+$ Pin                                         | $(V_{CC} - 0.3)V$ to +14V         |
| $V^-$ Pin                                         | +0.3V to -14V                     |
| Driver Input Voltage                              | -0.3V to (V <sub>CC</sub> + 0.3V) |
| Driver Output Voltage                             | $(V^+ + 0.3V)$ to $(V^- - 0.3V)$  |
| Receiver Input Voltage                            | ±25V                              |
| Receiver Output Voltage                           | -0.3V to $(V_{CC} + 0.3V)$        |
| Junction Temperature                              | +150°C                            |
| Maximum Package Power Dissipation @ 25°C (Note 6) |                                   |
| N Package                                         | 1698 mW                           |
| M Package                                         | 1156 mW                           |
| WM Package                                        | 1376 mW                           |

Short Circuit Duration,  $D_{OUT}$ 

Storage Temp. Range

Lead Temp. (Soldering, 4 sec.)

ESD Rating (HBM, 1.5 k $\Omega$ , 100 pF)

Continuous

-65°C to +150°C

+260°C

≥ 2.5 kV

## Recommended Operating Conditions

|                                    | Min | Max | Units |
|------------------------------------|-----|-----|-------|
| Supply Voltage, $V_{CC}$           | 4.5 | 5.5 | V     |
| Operating Free Air Temp. ( $T_A$ ) |     |     |       |
| DS14C232C                          | 0   | +70 | °C    |
| DS14C232T                          | -40 | +85 | °C    |

## Electrical Characteristics Over recommended operating conditions, unless otherwise specified (Note 2)

2

| Symbol                             | Parameter                         | Conditions                                                                           | Min                                        | Typ   | Max             | Units         |            |
|------------------------------------|-----------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------|-------|-----------------|---------------|------------|
| DC TO DC CONVERTER CHARACTERISTICS |                                   |                                                                                      |                                            |       |                 |               |            |
| V+                                 | Positive Power Supply             | $R_L = 3\text{ k}\Omega$ , $C1-C4 = 1.0\text{ }\mu\text{F}$ , $D_{IN} = 0.8\text{V}$ |                                            | 9.0   |                 | V             |            |
| V-                                 | Negative Power Supply             | $R_L = 3\text{ k}\Omega$ , $C1-C4 = 1.0\text{ }\mu\text{F}$ , $D_{IN} = 2.0\text{V}$ |                                            | -8.5  |                 | V             |            |
| I <sub>CC</sub>                    | Supply (V <sub>CC</sub> ) Current | No Load                                                                              |                                            | 1.0   | 3.0             | mA            |            |
| DRIVER CHARACTERISTICS             |                                   |                                                                                      |                                            |       |                 |               |            |
| V <sub>IH</sub>                    | High Level Input Voltage          |                                                                                      | 2                                          |       | V <sub>CC</sub> | V             |            |
| V <sub>IL</sub>                    | Low Level Input Voltage           |                                                                                      | GND                                        |       | 0.8             | V             |            |
| I <sub>IH</sub>                    | High Level Input Current          | $V_{IN} \geq 2.0\text{V}$                                                            | -10                                        |       | +10             | $\mu\text{A}$ |            |
| I <sub>IL</sub>                    | Low Level Input Current           | $V_{IN} \leq 0.8\text{V}$                                                            | -10                                        |       | +10             | $\mu\text{A}$ |            |
| V <sub>OH</sub>                    | High Level Output Voltage         | $R_L = 3\text{ k}\Omega$                                                             | 5.0                                        | 8.0   |                 | V             |            |
| V <sub>OL</sub>                    | Low Level Output Voltage          | $R_L = 3\text{ k}\Omega$                                                             |                                            | -7.0  | -5.0            | V             |            |
| I <sub>OS+</sub>                   | Output High Short Circuit Current | $V_O = 0\text{V}$ , $V_{IN} = 0.8\text{V}$                                           | (Note 3)                                   | -30   | -15             | -5.0          | mA         |
| I <sub>OS-</sub>                   | Output Low Short Circuit Current  | $V_O = 0\text{V}$ , $V_{IN} = 2\text{V}$                                             |                                            | 5.0   | 11              | 30            | mA         |
| R <sub>O</sub>                     | Output Resistance                 | $-2\text{V} \leq V_O \leq +2\text{V}$ ,<br>$V_{CC} = 0\text{V} = \text{GND}$         | 300                                        |       |                 | $\Omega$      |            |
| RECEIVER CHARACTERISTICS           |                                   |                                                                                      |                                            |       |                 |               |            |
| V <sub>TH</sub>                    | Input High Threshold Voltage      | $V_{CC} = 5.0\text{V}$                                                               |                                            | 1.9   | 2.4             | V             |            |
|                                    |                                   | $V_{CC} = 5.0\text{V} \pm 10\%$                                                      |                                            | 1.9   | 2.6             | V             |            |
| V <sub>TL</sub>                    | Input Low Threshold Voltage       |                                                                                      | 0.8                                        | 1.5   |                 | V             |            |
| V <sub>HY</sub>                    | Hysteresis                        | $T_A = 0^\circ\text{C to } +85^\circ\text{C}$                                        | 0.2                                        | 0.4   | 1.0             | V             |            |
|                                    |                                   | $T_A = -40^\circ\text{C to } 0^\circ\text{C}$                                        | 0.1                                        | 0.4   | 1.0             | V             |            |
| R <sub>IN</sub>                    | Input Resistance                  | $T_A = 0^\circ\text{C to } +85^\circ\text{C}$                                        | $-15\text{V} \leq V_{IN} \leq +15\text{V}$ | 3.0   | 4.7             | 7.0           | k $\Omega$ |
|                                    |                                   | $T_A = -40^\circ\text{C to } 0^\circ\text{C (Note 8)}$                               |                                            | 3.0   | 4.7             | 10            | k $\Omega$ |
| I <sub>IN</sub>                    | Input Current                     | $V_{IN} = +15\text{V}$                                                               | $0^\circ\text{C to } +85^\circ\text{C}$    | +2.14 | +3.75           | +5.0          | mA         |
|                                    |                                   | $V_{IN} = +3\text{V}$                                                                |                                            | +0.43 | +0.64           | +1.0          | mA         |
|                                    |                                   | $V_{IN} = -3\text{V}$                                                                |                                            | -1.0  | -0.64           | -0.43         | mA         |
|                                    |                                   | $V_{IN} = -15\text{V}$                                                               |                                            | -5.0  | -3.75           | -2.14         | mA         |
| V <sub>OH</sub>                    | High Level Output Voltage         | $V_{IN} = -3\text{V}$ , $I_O = -3.2\text{ mA}$                                       | 3.5                                        | 4.5   |                 | V             |            |
|                                    |                                   | $V_{IN} = -3\text{V}$ , $I_O = -20\text{ }\mu\text{A}$                               | 4.0                                        | 4.9   |                 | V             |            |
| V <sub>OL</sub>                    | Low Level Output Voltage          | $V_{IN} = +3\text{V}$ , $I_O = +3.2\text{ mA}$                                       |                                            | 0.15  | 0.4             | V             |            |

## COMMERCIAL

**Switching Characteristics** Over recommended operating conditions, unless otherwise specified.

| Symbol                   | Parameter                                 | Conditions                                                               |                               | Min | Typ | Max | Units |
|--------------------------|-------------------------------------------|--------------------------------------------------------------------------|-------------------------------|-----|-----|-----|-------|
| DRIVER CHARACTERISTICS   |                                           |                                                                          |                               |     |     |     |       |
| t <sub>PLH</sub>         | Propagation Delay Low to High             | R <sub>L</sub> = 3 kΩ<br>C <sub>L</sub> = 50 pF                          | Figure 1<br>and<br>Figure 2   |     | 1.0 | 4.0 | μs    |
| t <sub>PHL</sub>         | Propagation Delay High to Low             |                                                                          |                               |     | 1.0 | 4.0 | μs    |
| t <sub>SK</sub>          | Skew  t <sub>PLH</sub> – t <sub>PHL</sub> |                                                                          |                               |     | 0.1 | 1.0 | μs    |
| SR1                      | Output Slew Rate                          | R <sub>L</sub> = 3 kΩ to 7 kΩ, C <sub>L</sub> = 50 pF                    | (Note 7)                      | 4.0 |     | 30  | V/μs  |
| SR2                      | Output Slew Rate                          | R <sub>L</sub> = 3 kΩ, C <sub>L</sub> = 2500 pF                          |                               |     | 4.5 |     | V/μs  |
| RECEIVER CHARACTERISTICS |                                           |                                                                          |                               |     |     |     |       |
| t <sub>PLH</sub>         | Propagation Delay Low to High             | Input Pulse Width > 10 μs<br>C <sub>L</sub> = 50 pF<br>(Figures 3 and 4) |                               |     | 2.9 | 6.5 | μs    |
| t <sub>PHL</sub>         | Propagation Delay High to Low             |                                                                          |                               |     | 2.5 | 6.5 | μs    |
| t <sub>SK</sub>          | Skew  t <sub>PLH</sub> – t <sub>PHL</sub> |                                                                          |                               |     | 0.4 | 2.0 | μs    |
| t <sub>nw</sub>          | Noise Pulse Width Rejected                | (Figures 3 and 4)                                                        | T <sub>A</sub> = 0°C to +85°C |     | 0.7 | 0.5 | μs    |
|                          |                                           |                                                                          | T <sub>A</sub> = –40°C to 0°C |     | 0.7 | 0.3 | 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:  $t_r = t_f = 200\text{ ns}$ ,  $V_{IH} = 3\text{V}$ ,  $V_{IL} = -3\text{V}$ ,  $f = 30\text{ kHz}$ .

**Note 5:** All typicals are given for  $V_{CC} = 5.0\text{V}$ .

**Note 6:** Ratings apply to ambient temperature at  $+25^\circ\text{C}$ . Above this temperature derate: N Package  $15.6\text{ mW}/^\circ\text{C}$ , M Package  $10.6\text{ mW}/^\circ\text{C}$  and WM Package  $12.7\text{ mW}/^\circ\text{C}$ .

**Note 7:** Slew rate is defined as  $\Delta V/\Delta t$ , measured between  $\pm 3\text{V}$  level.

**Note 8:** TIA/EIA-232-E receiver input impedance maximum limit is  $7\text{ k}\Omega$ .

## MIL-STD 883C

## Absolute Maximum Ratings (Note 1)

The 883 specifications are written to reflect the Rel Electrical Test Specifications (RETS) established by National Semiconductor for this product. For a copy of the RETS please contact your local National Semiconductor sales office or distributor.

|                                                   |                                |
|---------------------------------------------------|--------------------------------|
| Supply Voltage, $V_{CC}$                          | -0.3V to 6V                    |
| V+ Pin                                            | $(V_{CC} - 0.3)V$ to +14V      |
| V- Pin                                            | +0.3V to -14V                  |
| Driver Input Voltage                              | -0.3V to $(V_{CC} + 0.3)V$     |
| Driver Output Voltage                             | $(V+ + 0.3V)$ to $(V- - 0.3V)$ |
| Receiver Input Voltage                            | $\pm 25V$                      |
| Receiver Output Voltage                           | -0.3V to $(V_{CC} + 0.3)V$     |
| Maximum Package Power Dissipation @ 25°C (Note 8) |                                |
| J Package                                         | 1520 mW                        |
| E Package                                         | 2000 mW                        |

|                                           |                 |
|-------------------------------------------|-----------------|
| Short Circuit Duration, $D_{OUT}$         | Continuous      |
| Storage Temp. Range                       | -65°C to +150°C |
| Lead Temp. (Soldering, 4 sec.)            | +260°C          |
| ESD Rating (HMB, 1.5 k $\Omega$ , 100 pF) | $\geq 2.5$ kV   |

## Recommended Operating Conditions

|                                    | Min | Max  | Units |
|------------------------------------|-----|------|-------|
| Supply Voltage, $V_{CC}$           | 4.5 | 5.5  | V     |
| Operating Free Air Temp. ( $T_A$ ) |     |      |       |
| DS14C232                           | -55 | +125 | °C    |

## Electrical Characteristics Over recommended operating conditions, unless otherwise specified (Note 2)

| Symbol                                                          | Parameter                         | Conditions                                                        | Min      | Max  | Units      |
|-----------------------------------------------------------------|-----------------------------------|-------------------------------------------------------------------|----------|------|------------|
| <b>DEVICE CHARACTERISTICS (C1-C4 = 1.0 <math>\mu</math>F)</b>   |                                   |                                                                   |          |      |            |
| $I_{CC}$                                                        | Supply ( $V_{CC}$ ) Current       | No Load                                                           |          | 8.0  | mA         |
| <b>DRIVER CHARACTERISTICS</b>                                   |                                   |                                                                   |          |      |            |
| $V_{IH}$                                                        | High Level Input Voltage          |                                                                   | 2        |      | V          |
| $V_{IL}$                                                        | Low Level Input Voltage           |                                                                   |          | 0.8  | V          |
| $I_{IH}$                                                        | High Level Input Current          | $V_{IN} \geq 2.0V$                                                |          | 100  | $\mu$ A    |
| $I_{IL}$                                                        | Low Level Input Current           | $V_{IN} = 0V$                                                     |          | 100  | $\mu$ A    |
| $V_{OH}$                                                        | High Level Output Voltage         | $R_L = 3$ k $\Omega$                                              | 5.0      |      | V          |
| $V_{OL}$                                                        | Low Level Output Voltage          | $R_L = 3$ k $\Omega$                                              |          | -5.0 | V          |
| $I_{OS+}$                                                       | Output High Short Circuit Current | $V_O = 0V$                                                        | (Note 3) | -25  | mA         |
| $I_{OS-}$                                                       | Output Low Short Circuit Current  | $V_O = 0V$                                                        |          | 25   | mA         |
| $R_O$                                                           | Output Resistance                 | $-2V \leq V_O \leq +2V, T_A = 25^\circ C,$<br>$V_{CC} = 0V = GND$ | 300      |      | $\Omega$   |
| <b>RECEIVER CHARACTERISTICS (C1-C4 = 1.0 <math>\mu</math>F)</b> |                                   |                                                                   |          |      |            |
| $V_{TH}$                                                        | Input High Threshold Voltage      |                                                                   |          | 3.0  | V          |
| $V_{TL}$                                                        | Input Low Threshold Voltage       |                                                                   | 0.2      |      | V          |
| $V_{HY}$                                                        | Hysteresis                        | $T_A = 25^\circ C, +125^\circ C$                                  | 0.1      | 1.0  | V          |
|                                                                 |                                   | $T_A = -55^\circ C$                                               | 0.05     | 1.0  | V          |
| $R_{IN}$                                                        | Input Resistance                  | $V_{IN} = \pm 3V$ and $\pm 15V, T_A = 25^\circ C$                 | 3.0      | 7.0  | k $\Omega$ |
| $V_{OH}$                                                        | High Level Output Voltage         | $I_O = -3.2$ mA                                                   | 3.5      |      | V          |
|                                                                 |                                   | $I_O = -20$ $\mu$ A                                               | 4.0      |      | V          |
| $V_{OL}$                                                        | Low Level Output Voltage          | $I_O = +3.2$ mA                                                   |          | 0.4  | V          |

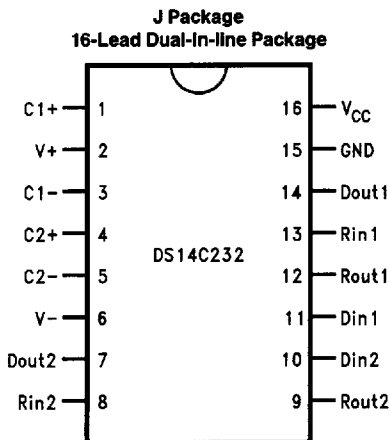
## MIL-STD-883C

## Switching Characteristics Over recommended operating conditions, unless otherwise specified.

| Symbol                                                          | Parameter                     | Conditions                                                                          | Min | Max | Units      |
|-----------------------------------------------------------------|-------------------------------|-------------------------------------------------------------------------------------|-----|-----|------------|
| <b>DRIVER CHARACTERISTICS (C1–C4 = 1.0 <math>\mu</math>F)</b>   |                               |                                                                                     |     |     |            |
| $t_{PLH}$                                                       | Propagation Delay Low to High | $R_L = 3\text{ k}\Omega$ , $C_L = 50\text{ pF}$<br><i>Figures 1 and 2</i>           |     | 4.0 | $\mu$ s    |
| $t_{PHL}$                                                       | Propagation Delay High to Low |                                                                                     |     | 4.0 | $\mu$ s    |
| $t_{SK}$                                                        | Skew $ t_{PLH} - t_{PHL} $    |                                                                                     |     | 1.0 | $\mu$ s    |
| SR1                                                             | Output Slew Rate              | $R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$ , $C_L = 2500\text{ pF}$<br>(Note 7) | 1.5 | 30  | V/ $\mu$ s |
| <b>RECEIVER CHARACTERISTICS (C1–C4 = 1.0 <math>\mu</math>F)</b> |                               |                                                                                     |     |     |            |
| $t_{PLH}$                                                       | Propagation Delay Low to High | Input Pulse Width > 10 $\mu$ s<br>$C_L = 50\text{ pF}$<br>(Figures 3 and 4)         |     | 8.0 | $\mu$ s    |
| $t_{PHL}$                                                       | Propagation Delay High to Low |                                                                                     |     | 8.0 | $\mu$ s    |
| $t_{SK}$                                                        | Skew $ t_{PLH} - t_{PHL} $    |                                                                                     |     | 2.0 | $\mu$ s    |

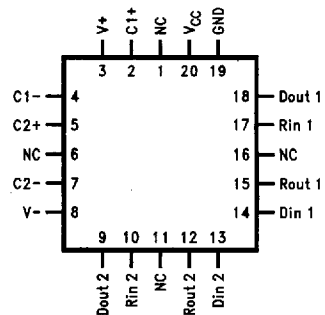
Note 8: Ratings apply to ambient temperature at +25°C. Above this temperature derate: J Package 12.2 mW/°C and E Package 13.3 mW/°C.

## Connection Diagrams (Continued)



TL/F/10744-1

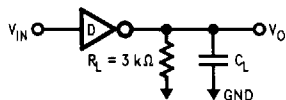
**E Package**  
20-Lead Ceramic Leadless Chip Carrier



TL/F/10744-10

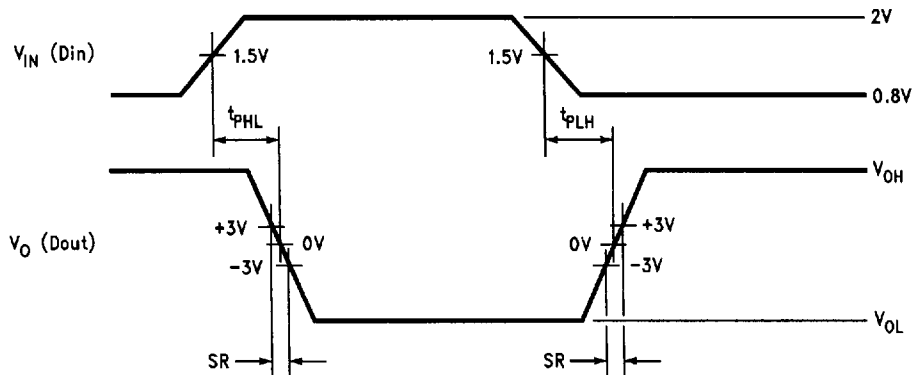
For Complete Military 883 Specifications  
See RETS Data Sheet.  
Order Number DS14C232J/883 or DS14C232E/883  
See NS Package Number E20A or J16A

## Parameter Measurement Information



TL/F/10744-3

FIGURE 1. Driver Load Circuit



TL/F/10744-4

FIGURE 2. Driver Switching Waveform

## Parameter Measurement Information (Continued)

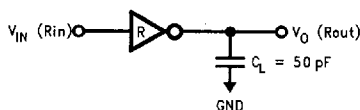


FIGURE 3. Receiver Load Circuit

TL/F/10744-5

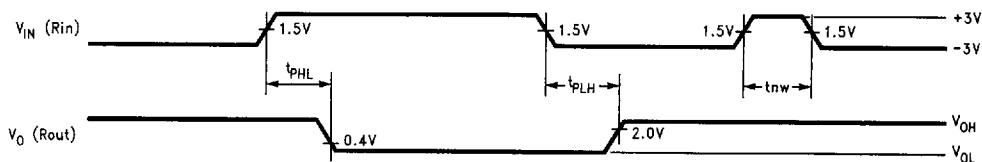


FIGURE 4. Receiver Propagation Delays and Noise Rejection (Note 4)

TL/F/10744-6

## Pin Descriptions

### V<sub>CC</sub> (Pin 16)

Power supply pin for the device, +5V ( $\pm 10\%$ ).

### V<sup>+</sup> (Pin 2)

Positive supply for TIA/EIA-232-E drivers. Recommended external capacitor: C4-1.0  $\mu$ F (6.3V). Capacitor value should be larger than 1  $\mu$ F. This supply is not intended to be loaded externally.

### V<sup>-</sup> (Pin 6)

Negative supply for TIA/EIA-232-E drivers. Recommended external capacitor: C3-1.0  $\mu$ F (16V). Capacitor value should be larger than 1  $\mu$ F. This supply is not intended to be loaded externally.

### C1<sup>+</sup>, C1<sup>-</sup> (Pins 1, 3)

External capacitor connection pins. Recommended capacitor: 1.0  $\mu$ F (6.3V). Capacitor value should be larger than 1  $\mu$ F.

### C2<sup>+</sup>, C2<sup>-</sup> (Pins 4, 5)

External capacitor connection pins. Recommended capacitor: 1.0  $\mu$ F (16V). Capacitor value should be greater than 1  $\mu$ F.

### D<sub>IN</sub>1, D<sub>IN</sub>2 (Pins 11, 10)

Driver input pins are TTL/CMOS compatible. Inputs of unused drivers may be left open, an internal active pull-up resistor (500 k $\Omega$  minimum, typically 5 M $\Omega$ ) pulls input HIGH. Output will be LOW for open inputs.

### D<sub>OUT</sub>1, D<sub>OUT</sub>2 (Pins 14, 7)

Driver output pins conform to TIA/EIA-232-E levels.

### R<sub>IN</sub>1, R<sub>IN</sub>2 (Pins 13, 8)

Receiver input pins accept TIA/EIA-232-E input voltages ( $\pm 25$ V). Receivers feature a noise filter and guaranteed hysteresis of 100 mV. Unused receiver input pins may be left open. Internal input resistor 4.7 k $\Omega$  pulls input low, providing a failsafe high output.

### R<sub>OUT</sub>1, R<sub>OUT</sub>2 (Pins 12, 9)

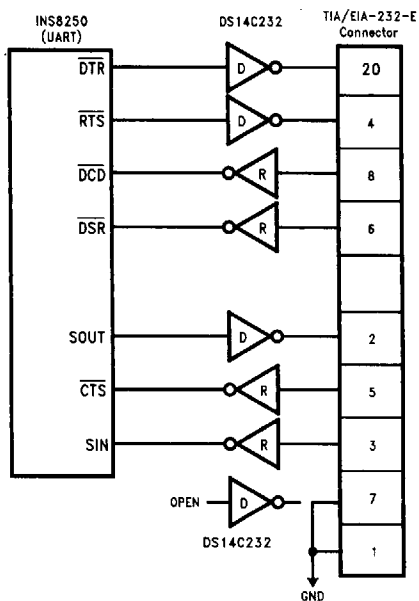
Receiver output pins are TTL/CMOS compatible. Receiver output HIGH voltage is specified for both CMOS and TTL load conditions.

### GND (Pin 15)

Ground Pin.

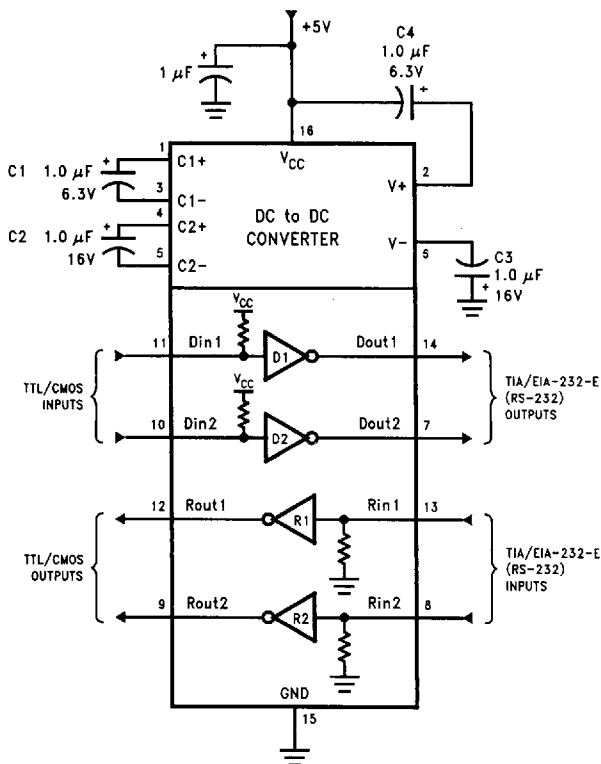
## Typical Application Information

Application of DS14C232 and INS8250



TL/F/10744-7

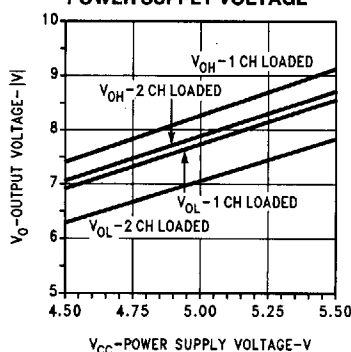
## Typical Connection Diagram



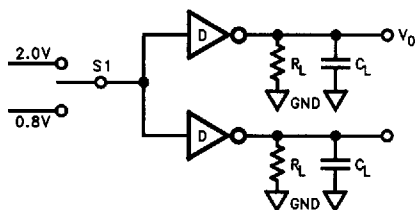
TL/F/10744-8

# Typical Performance Characteristics

## DRIVER $V_{OH}$ & $V_{OL}$ vs POWER SUPPLY VOLTAGE

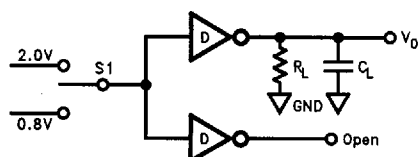


TL/F/10744-11



TL/F/10744-12

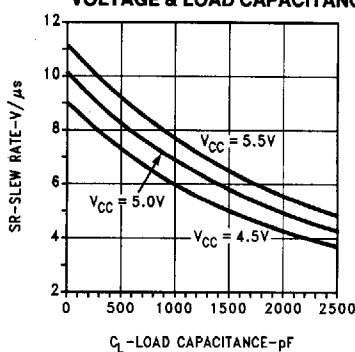
$V_{CC} = 5.0V$ ,  $R_L = 3\text{ k}\Omega$ ,  $C_L = 15\text{ pF}$  (includes jig and probe capacitance),  
 $C_p = 1\text{ }\mu\text{F}$



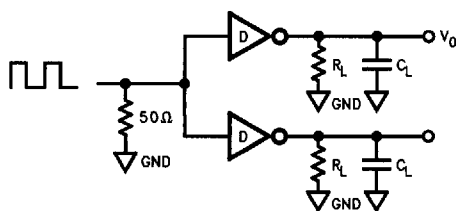
TL/F/10744-13

| S1   | $V_O$    |
|------|----------|
| 2.0V | $V_{OL}$ |
| 0.8V | $V_{OH}$ |

## DRIVER SLEW RATE vs POWER SUPPLY VOLTAGE & LOAD CAPACITANCE

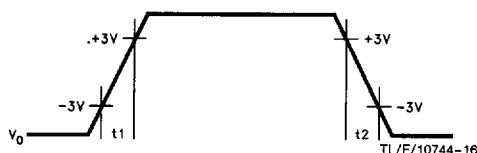


TL/F/10744-14



TL/F/10744-15

$T_a = 25^\circ\text{C}$ ,  $R_L = 5\text{ k}\Omega$ ,  $C_p = 1\text{ }\mu\text{F}$ ,  $f = 30\text{ KHz}$



TL/F/10744-16

$SR = 6V/t_1$  or  $6V/t_2$ , whichever is greater.