# SN75C1406
# TRIPLE LOW-POWER DRIVERS/RECEIVERS

SLLS148D – MAY 1990 – REVISED DECEMBER 1999

- **Meet or Exceed the Requirements of TIA/EIA-232-F and ITU Recommendation V.28**
- **Very Low Power Consumption . . . 5 mW Typ**
- **Wide Driver Supply Voltage Range . . . ±4.5 V to ±15 V**
- **Driver Output Slew Rate Limited to 30 V/μs Max**
- **Receiver Input Hysteresis . . . 1000 mV Typ**
- **Push-Pull Receiver Outputs**
- **On-Chip Receiver 1-μs Noise Filter**
- **Functionally Interchangeable With Motorola MC145406 and Texas Instruments TL145406**
- **Package Options Include Plastic Small-Outline (D, DW, NS) Packages and (N) DIPs**

**D, DW, N, OR NS PACKAGE**
**(TOP VIEW)**

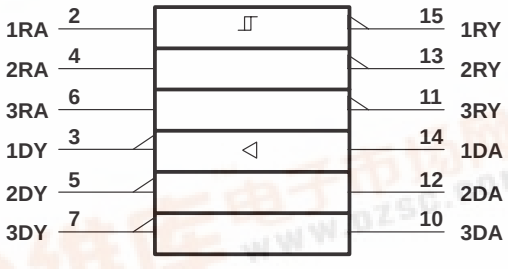

## description

The SN75C1406 is a low-power BiMOS device containing three independent drivers and receivers that are used to interface data terminal equipment (DTE) with data circuit-terminating equipment (DCE). This device is designed to conform to TIA/EIA-232-F. The drivers and receivers of the SN75C1406 are similar to those of the SN75C188 quadruple driver and SN75C189A quadruple receiver, respectively. The drivers have a controlled output slew rate that is limited to a maximum of 30 V/μs, and the receivers have filters that reject input noise pulses shorter than 1 μs. Both these features eliminate the need for external components.

The SN75C1406 is designed using low-power techniques in a BiMOS technology. In most applications, the receivers contained in these devices interface to single inputs of peripheral devices such as ACEs, UARTs, or microprocessors. By using sampling, such peripheral devices are usually insensitive to the transition times of the input signals. If this is not the case, or for other uses, it is recommended that the SN75C1406 receiver outputs be buffered by single Schmitt input gates or single gates of the HCMOS, ALS, or 74F logic families.

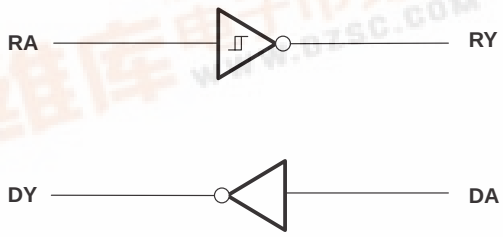
The SN75C1406 is characterized for operation from 0°C to 70°C.

## logic symbol†




† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

## logic diagram, each driver and receiver

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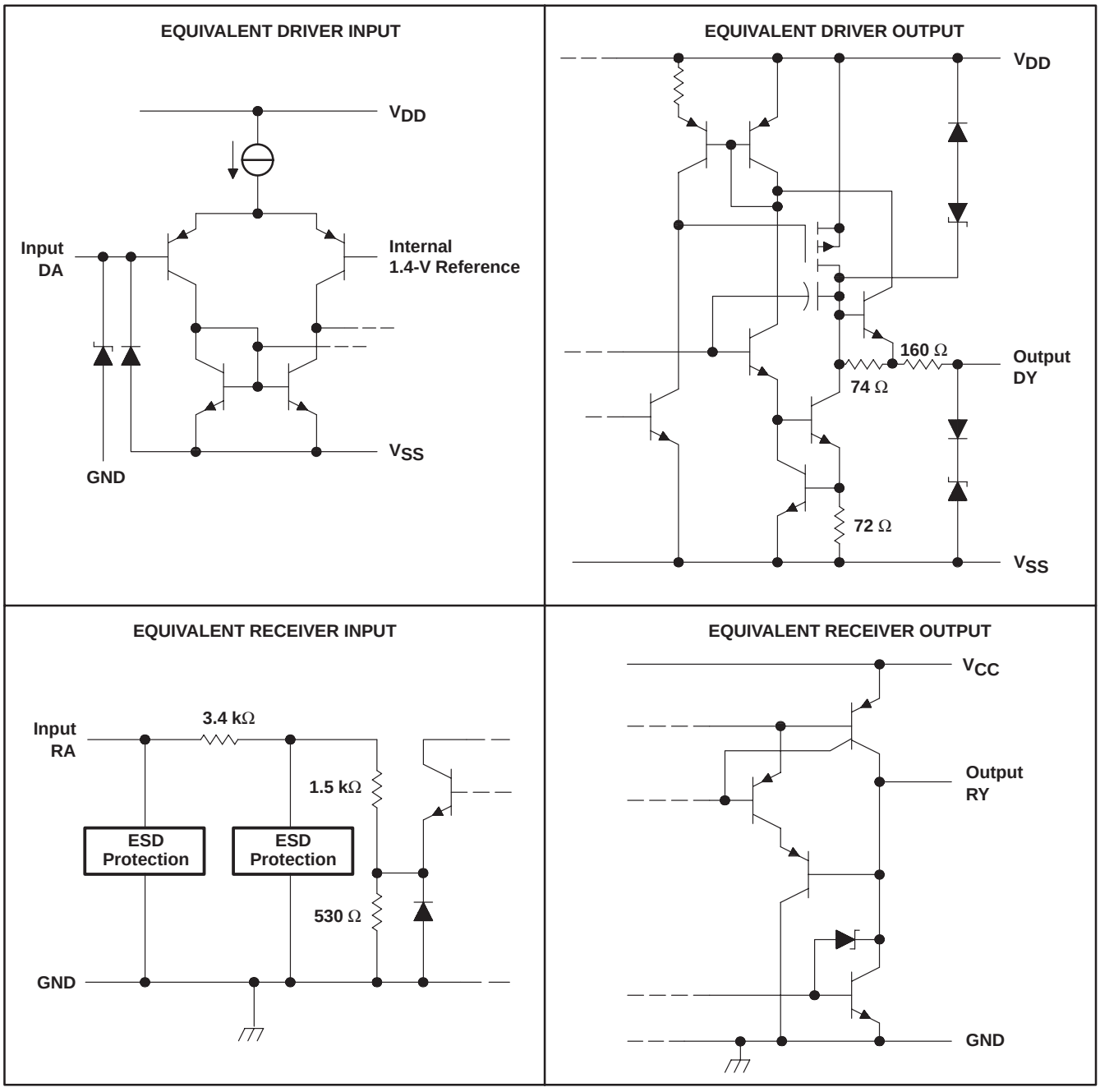
## schematics of inputs and outputs




All resistor values shown are nominal.

### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{DD}$ (see Note 1) . . . . . 15 V
Supply voltage, $V_{SS}$ . . . . . –15 V
Supply voltage, $V_{CC}$ . . . . . 7 V
Input voltage range, $V_I$: Driver . . . . . $V_{SS}$ to $V_{DD}$
Receiver . . . . . –30 V to 30 V
Output voltage range, $V_O$: Driver . . . . . ($V_{SS}$ – 6 V) to ($V_{DD}$ + 6 V)
Receiver . . . . . –0.3 V to ($V_{CC}$ + 0.3 V)
Package thermal impedance, $\theta_{JA}$ (see Note 2): D package . . . . . 73°C/W
DW package . . . . . 57°C/W
N package . . . . . 67°C/W
NS package . . . . . 64°C/W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C
Storage temperature range, $T_{stg}$ . . . . . –65°C to 150 °C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltages are with respect to the network ground terminal.
2. The package thermal impedance is calculated in accordance with JESD 51.

### recommended operating conditions

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| Supply voltage, $V_{DD}$ | | 4.5 | 12 | 15 | V |
| Supply voltage, $V_{SS}$ | | –4.5 | –12 | –15 | V |
| Supply voltage, $V_{CC}$ | | 4.5 | 5 | 6 | V |
| Input voltage, $V_I$ | Driver | $V_{SS}$+2 | | $V_{DD}$ | V |
| | Receiver | | | ±25 | |
| High-level input voltage, $V_{IH}$ | | 2 | | | V |
| Low-level input voltage, $V_{IL}$ | | | | 0.8 | V |
| High-level output current, $I_{OH}$ | | | | –1 | mA |
| Low-level output current, $I_{OL}$ | | | | 3.2 | mA |
| Operating free-air temperature, $T_A$ | | 0 | | 70 | °C |

## DRIVER SECTION

### electrical characteristics over operating free-air temperature range, $V_{DD}$ = 12 V, $V_{SS}$ = −12 V, $V_{CC}$ = 5 V ± 10% (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | | MIN | TYP† | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | $V_{IH}$ = 0.8 V, See Figure 1 | $R_L$ = 3 kΩ, | $V_{DD}$ = 5 V, $V_{SS}$ = −5 V | 4 | 4.5 | | V |
| | | | | $V_{DD}$ = 12 V, $V_{SS}$ = −12 V | 10 | 10.8 | | |
| $V_{OL}$ | Low-level output voltage (see Note 3) | $V_{IH}$ = 2 V, See Figure 1 | $R_L$ = 3 kΩ, | $V_{DD}$ = 5 V, $V_{SS}$ = −5 V | | −4.4 | −4 | V |
| | | | | $V_{DD}$ = 12 V, $V_{SS}$ = −12 V | | −10.7 | −10 | |
| $I_{IH}$ | High-level input current | $V_I$ = 5 V, | See Figure 2 | | | | 1 | µA |
| $I_{IL}$ | Low-level input current | $V_I$ = 0, | See Figure 2 | | | | −1 | |
| $I_{OS(H)}$ | High-level short-circuit output current‡ | $V_I$ = 0.8 V, | $V_O$ = 0 or $V_{SS}$, | See Figure 1 | −7.5 | −12 | −19.5 | mA |
| $I_{OS(L)}$ | Low-level short-circuit output current‡ | $V_I$ = 2 V, | $V_O$ = 0 or $V_{DD}$, | See Figure 1 | 7.5 | 12 | 19.5 | mA |
| $I_{DD}$ | Supply current from $V_{DD}$ | No load, All inputs at 2 V or 0.8 V | | $V_{DD}$ = 5 V, $V_{SS}$ = −5 V | | 115 | 250 | µA |
| | | | | $V_{DD}$ = 12 V, $V_{SS}$ = −12 V | | 115 | 250 | |
| $I_{SS}$ | Supply current from $V_{SS}$ | No load, All inputs at 2 V or 0.8 V | | $V_{DD}$ = 5 V, $V_{SS}$ = −5 V | | −115 | −250 | µA |
| | | | | $V_{DD}$ = 12 V, $V_{SS}$ = −12 V | | −115 | −250 | |
| $r_O$ | Output resistance | $V_{DD}$ = $V_{SS}$ = $V_{CC}$ = 0, See Note 4 | | $V_O$ = −2 V to 2 V, | 300 | 400 | | Ω |

† All typical values are at $T_A$ = 25°C.
‡ Not more than one output should be shorted at a time.

NOTES: 3. The algebraic convention, where the more positive (less negative) limit is designated as maximum, is used in this data sheet for logic levels only.
4. Test conditions are those specified by TIA/EIA-232-F.

### switching characteristics at $T_A$ = 25°C, $V_{DD}$ = 12 V, $V_{SS}$ = −12 V, $V_{CC}$ = 5 V ± 10%

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{PLH}$ | Propagation delay time, low- to high-level output§ | $R_L$ = 3 kΩ to 7 kΩ, $C_L$ = 15 pF, See Figure 3 | | 1.2 | 3 | µs |
| $t_{PHL}$ | Propagation delay time, high- to low-level output§ | | | 2.5 | 3.5 | µs |
| $t_{TLH}$ | Transition time, low- to high-level output¶ | | 0.53 | 2 | 3.2 | µs |
| $t_{THL}$ | Transition time, high- to low-level output¶ | | 0.53 | 2 | 3.2 | µs |
| $t_{TLH}$ | Transition time, low- to high-level output# | $R_L$ = 3 kΩ to 7 kΩ, $C_L$ = 2500 pF, See Figure 3 | | 1 | 2 | µs |
| $t_{THL}$ | Transition time, high- to low-level output# | $R_L$ = 3 kΩ to 7 kΩ, $C_L$ = 2500 pF, See Figure 3 | | 1 | 2 | µs |
| SR | Output slew rate | $R_L$ = 3 kΩ to 7 kΩ, $C_L$ = 15 pF, See Figure 3 | 4 | 10 | 30 | V/µs |

§ $t_{PHL}$ and $t_{PLH}$ include the additional time due to on-chip slew rate and are measured at the 50% points.
¶ Measured between 10% and 90% points of output waveform
# Measured between 3-V and −3-V points of output waveform (TIA/EIA-232-F conditions) with all unused inputs tied either high or low

## RECEIVER SECTION

### electrical characteristics over operating free-air temperature range, $V_{DD}$ = 12 V, $V_{SS}$ = −12 V, $V_{CC}$ = 5 V ± 10% (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | | MIN | TYP† | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{IT+}$ | Positive-going input threshold voltage | See Figure 5 | | | 1.7 | 2 | 2.55 | V |
| $V_{IT-}$ | Negative-going input threshold voltage | See Figure 5 | | | 0.65 | 1 | 1.25 | V |
| $V_{hys}$ | Input hysteresis voltage ($V_{IT+}$–$V_{IT-}$) | | | | 600 | 1000 | | mV |
| $V_{OH}$ | High-level output voltage | $V_I$ = 0.75 V, | $I_{OH}$ = −20 μA, | See Figure 5 and Note 5 | 3.5 | | | V |
| | | $V_I$ = 0.75 V, See Figure 5 | $I_{OH}$ = −1 mA, | $V_{CC}$ = 4.5 V | 2.8 | 4.4 | | |
| | | | | $V_{CC}$ = 5 V | 3.8 | 4.9 | | |
| | | | | $V_{CC}$ = 5.5 V | 4.3 | 5.4 | | |
| $V_{OL}$ | Low-level output voltage | $V_I$ = 3 V, | $I_{OL}$ = 3.2 mA, | See Figure 5 | | 0.17 | 0.4 | V |
| $I_{IH}$ | High-level input current | $V_I$ = 2.5 V | | | 3.6 | 4.6 | 8.3 | mA |
| | | $V_I$ = 3 V | | | 0.43 | 0.55 | 1 | |
| $I_{IL}$ | Low-level input current | $V_I$ = −2.5 V | | | −3.6 | −5 | −8.3 | |
| | | $V_I$ = −3 V | | | −0.43 | −0.55 | −1 | |
| $I_{OS(H)}$ | High-level short-circuit output current | $V_I$ = 0.75 V, | $V_O$ = 0, | See Figure 4 | | −8 | −15 | mA |
| $I_{OS(L)}$ | Low-level short-circuit output current | $V_I$ = $V_{CC}$, | $V_O$ = $V_{CC}$, | See Figure 4 | | 13 | 25 | mA |
| $I_{CC}$ | Supply current from $V_{CC}$ | No load, All inputs at 0 or 5 V | | $V_{DD}$ = 5 V, $V_{SS}$ = −5 V | | 320 | 450 | μA |
| | | | | $V_{DD}$ = 12 V, $V_{SS}$ = −12 V | | 320 | 450 | |

† All typical values are at $T_A$ = 25°C.

NOTE 5: If the inputs are left unconnected, the receiver interprets this as an input low and the receiver outputs remain in the high state.

### switching characteristics at $T_A$ = 25°C, $V_{DD}$ = 12 V, $V_{SS}$ = −12 V, $V_{CC}$ = 5 V ± 10% (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{PLH}$ | Propagation delay time, low- to high-level output | $C_L$ = 50 pF, $R_L$ = 5 kΩ, See Figure 6 | | 3 | 4 | μs |
| $t_{PHL}$ | Propagation delay time, high- to low-level output | | | 3 | 4 | μs |
| $t_{TLH}$ | Transition time, low- to high-level output‡ | | | 300 | 450 | ns |
| $t_{THL}$ | Transition time, high- to low-level output‡ | | | 100 | 300 | ns |
| $t_{w(N)}$ | Duration of longest pulse rejected as noise§ | $C_L$ = 50 pF, $R_L$ = 5 kΩ | 1 | | 4 | μs |

‡ Measured between 10% and 90% points of output waveform

§ The receiver ignores any positive- or negative-going pulse that is less than the minimum value of $t_{w(N)}$ and accepts any positive- or negative-going pulse greater than the maximum of $t_{w(N)}$.

## PARAMETER MEASUREMENT INFORMATION

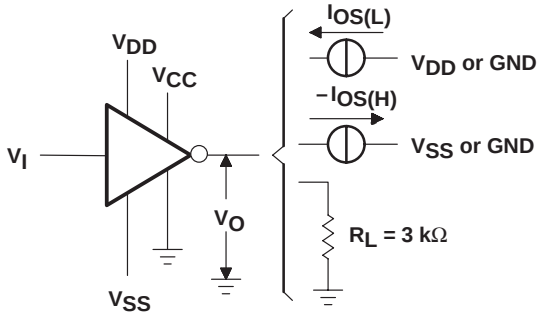



**Figure 1. Driver Test Circuit $V_{OH}$, $V_{OL}$, $I_{OS(L)}$, $I_{OS(H)}$**

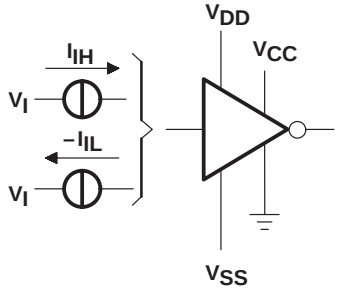
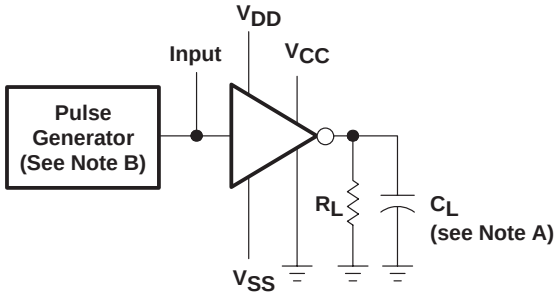
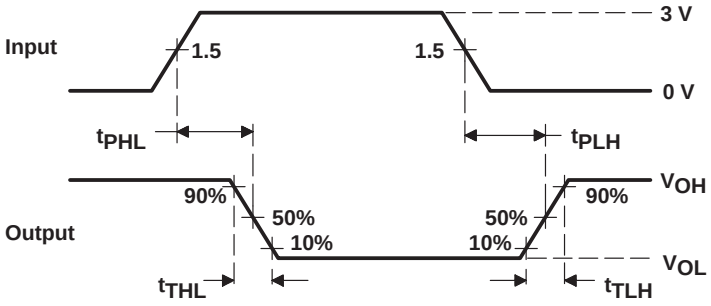



**Figure 2. Driver Test Circuit, $I_{IL}$, $I_{IH}$**




**TEST CIRCUIT**




**VOLTAGE WAVEFORMS**

NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: $t_W$ = 25 µs, PRR = 20 kHz, $Z_O$ = 50 Ω, $t_r$ = $t_f$ < 50 ns.

**Figure 3. Driver Test Circuit and Voltage Waveforms**

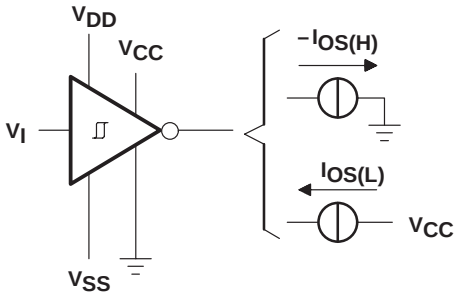



**Figure 4. Receiver Test Circuit, $I_{OS(H)}$, $I_{OS(L)}$**

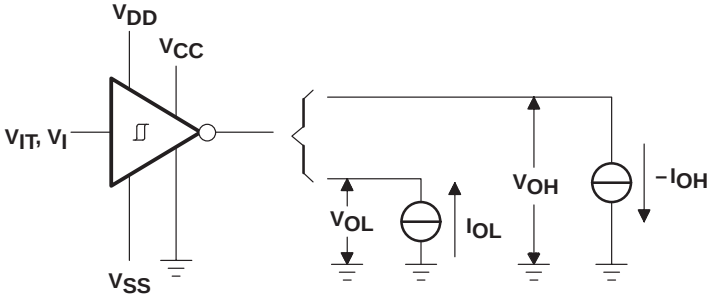
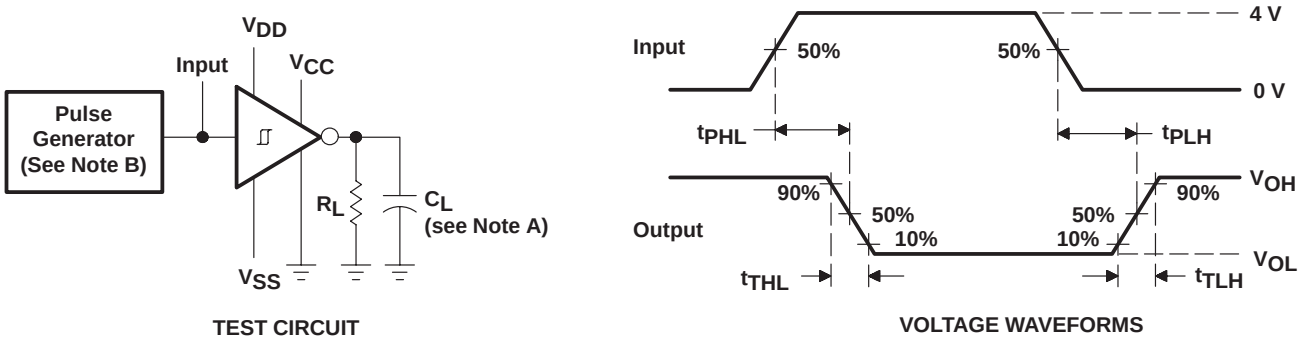



**Figure 5. Receiver Test Circuit, $V_{IT}$, $V_{OL}$, $V_{OH}$**

## PARAMETER MEASUREMENT INFORMATION




NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: $t_W$ = 25 µs, PRR = 20 kHz, $Z_O$ = 50 Ω, $t_r = t_f$ < 50 ns.

**Figure 6. Receiver Test Circuit and Voltage Waveforms**

## APPLICATION INFORMATION

The TIA/EIA-232-F specification is for data interchange between a host computer and a peripheral at signaling rates up to 20 kbit/s. Many TIA/EIA-232-F devices will operate at higher data rates with lower capacitive loads (short cables). For reliable operation at greater than 20 kbit/s, the designer needs to have control of both ends of the cable. By mixing different types of TIA/EIA-232-F devices and cable lengths, errors can occur at higher frequencies (above 20 kbit/s). When operating within the TIA/EIA-232-F requirements of less than 20 kbit/s and with compliant line circuits, interoperability is assured. For applications operating above 20 kbit/s, the design engineer should consider devices and system designs that meet the TIA/EIA-232-F requirements.

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