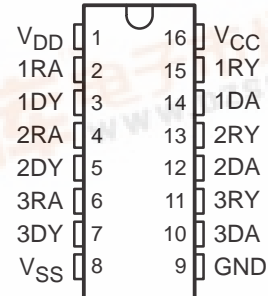


# TRIPLE RS-232 DRIVERS/RECEIVERS

SLLS185A – DECEMBER 1994 – REVISED MARCH 1995

- Meets or Exceeds the Requirements of ANSI EIA/TIA-232-E and ITU V.28
- Designed to Support Data Rates Up to 120 kbits/s Over 3-m Cable
- ESD Protection Exceeds 5 kV on All Pins
- Flow-Through Design
- Wide-Driver Supply Voltage . . .  $\pm 4.5$  V to  $\pm 15$  V
- Functionally Interchangeable With Motorola MC145406 and Texas Instruments SN75C1406

DW OR N PACKAGE  
(TOP VIEW)



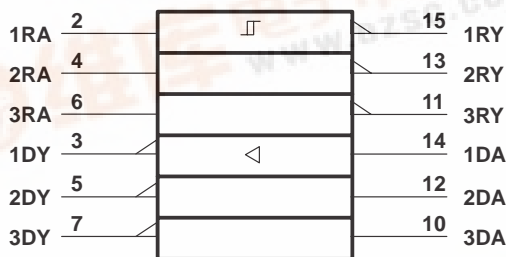
## description

The TL145406 is a bipolar device containing three independent drivers and receivers that are used to interface data terminal equipment (DTE) with data circuit-terminating equipment (DCE). The drivers and receivers of the TL145406 are similar to those of the SN75188 quadruple driver and SN75189A quadruple receiver, respectively. The pinout matches the flow-through design of the SN75C1406 to reduce the board space required and allow easy interconnection. The bipolar circuits and processing of the TL145406 provide a rugged low-cost solution for this function at the expense of quiescent power and external passive components relative to the SN75C1406.

The TL145406 complies with the requirements of the EIA/TIA 232-E and ITU (formerly CCITT) V.28 standards. These standards are for data interchange between a host computer and peripheral at signalling rates up to 20 kbit/s. The switching speeds of the TL145406 are fast enough to support rates up to 120 kbit/s with lower capacitive loads (shorter cables). Interoperability at the higher signalling rates cannot be assured unless the designer has design control of the cable and the interface circuits at both ends. For interoperability at signalling rates to 120 kbit/s, use of EIA/TIA-423-B (ITU V.10) and EIA/TIA-422-B (ITU V.11) standards are recommended.

The TL145406 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 (positive logic)

Typical of each receiver



Typical of each driver



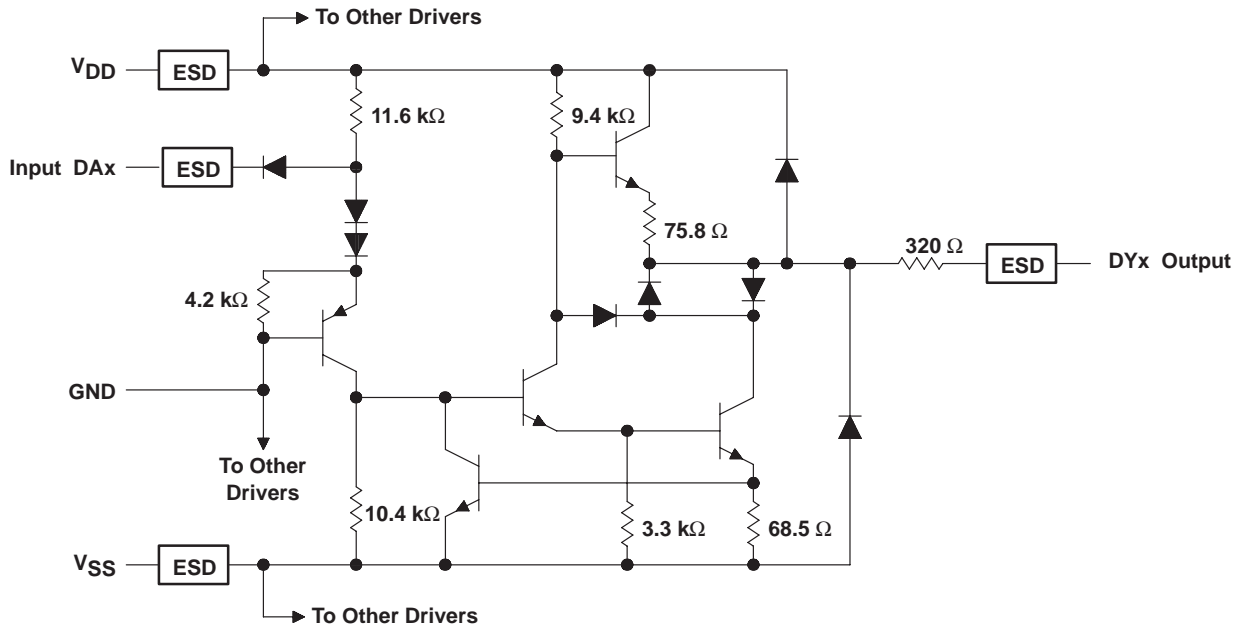
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



# TL145406 TRIPLE RS-232 DRIVERS/RECEIVERS

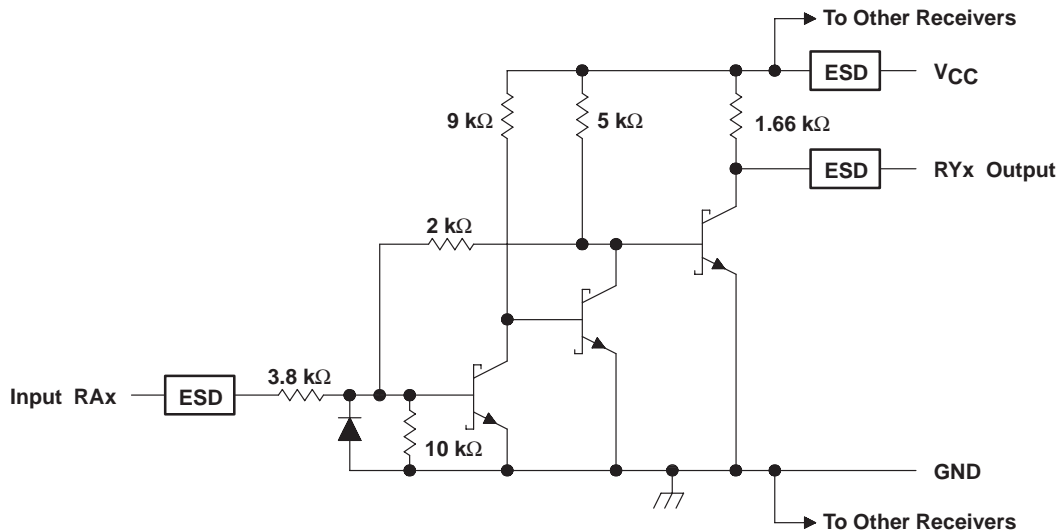
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## schematic (each driver)



Resistor values shown are nominal.

## schematic (each receiver)



Resistor values shown are nominal.

# TL145406 TRIPLE RS-232 DRIVERS/RECEIVERS

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

Supply voltage, $V_{CC}$ (see Note 1)	10 V
Supply voltage, $V_{DD}$ (see Note 1)	15 V
Supply voltage, $V_{SS}$ (see Note 1)	–15 V
Input voltage range: Driver	–15 V to 7 V
Receiver	–30 V to 30 V
Driver output voltage range	–15 V to 15 V
Receiver low-level output current	20 mA
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range, $T_A$	0°C to 70°C
Storage temperature range, $T_{stg}$	–65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°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.

NOTE 1: All voltages are with respect to the network ground terminal.

**DISSIPATION RATING TABLE‡**

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A \leq 70^\circ\text{C}$ POWER RATING
DW	1256 mW	9.7 mW/°C	819 mW
N	1943 mW	14.9 mW/°C	1272 mW

‡ Dissipation ratings are the inverse of the traditional junction-to-case thermal resistance ( $R_{\theta JA}$ ).

## recommended operating conditions

		MIN	NOM	MAX	UNIT
Supply voltage, $V_{DD}$		7.5	9	15	V
Supply voltage, $V_{SS}$		–7.5	–9	–15	V
Supply voltage, $V_{CC}$		4.5	5	5.5	V
High-level input voltage, $V_{IH}$ (driver only)		1.9			V
Low-level input voltage, $V_{IL}$ (driver only)				0.8	V
High-level output current, $I_{OH}$	Driver			–6	mA
	Receiver			–0.5	
Low-level output current, $I_{OL}$	Driver			6	mA
	Receiver			16	
Operating free-air temperature, $T_A$		0		70	°C

# TL145406

## TRIPLE RS-232 DRIVERS/RECEIVERS

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### supply currents

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
I <sub>DD</sub> Supply current from V <sub>DD</sub>	All inputs at 1.9 V, No load	V <sub>DD</sub> = 9 V, V <sub>SS</sub> = -9 V			15	mA
		V <sub>DD</sub> = 12 V, V <sub>SS</sub> = -12 V			19	
		V <sub>DD</sub> = 15 V, V <sub>SS</sub> = -15 V			25	
	All inputs at 0.8 V, No load	V <sub>DD</sub> = 9 V, V <sub>SS</sub> = -9 V			4.5	mA
		V <sub>DD</sub> = 12 V, V <sub>SS</sub> = -12 V			5.5	
		V <sub>DD</sub> = 15 V, V <sub>SS</sub> = -15 V			9	
I <sub>SS</sub> Supply current from V <sub>SS</sub>	All inputs at 1.9 V, No load	V <sub>DD</sub> = 9 V, V <sub>SS</sub> = -9 V			-15	mA
		V <sub>DD</sub> = 12 V, V <sub>SS</sub> = -12 V			-19	
		V <sub>DD</sub> = 15 V, V <sub>SS</sub> = -15 V			-25	
	All inputs at 0.8 V, No load	V <sub>DD</sub> = 9 V, V <sub>SS</sub> = -9 V			-3.2	mA
		V <sub>DD</sub> = 12 V, V <sub>SS</sub> = -12 V			-3.2	
		V <sub>DD</sub> = 15 V, V <sub>SS</sub> = -15 V			-3.2	
I <sub>CC</sub> Supply current from V <sub>CC</sub>	All inputs at 5 V, No load, V <sub>CC</sub> = 5 V			13.2	20	mA

### DRIVER SECTION

electrical characteristics over recommended operating free-air temperature range, V<sub>DD</sub> = 9 V, V<sub>SS</sub> = -9 V, V<sub>CC</sub> = 5 V (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V <sub>OH</sub> High-level output voltage	V <sub>IL</sub> = 0.8 V, R <sub>L</sub> = 3 kΩ, See Figure 1	6	7.5		V
V <sub>OL</sub> Low-level output voltage (see Note 2)	V <sub>IH</sub> = 1.9 V, R <sub>L</sub> = 3 kΩ, See Figure 1		-7.5	-6	V
I <sub>IH</sub> High-level input current	V <sub>I</sub> = 5 V, See Figure 2			10	μA
I <sub>IL</sub> Low-level input current	V <sub>I</sub> = 0, See Figure 2			-1.6	mA
I <sub>OS(H)</sub> High-level short-circuit output current (see Note 3)	V <sub>IL</sub> = 0.8 V, V <sub>O</sub> = 0 or V <sub>SS</sub> , See Figure 1	-4.5	-10	-19.5	mA
I <sub>OS(L)</sub> Low-level short-circuit output current	V <sub>IH</sub> = 2 V, V <sub>O</sub> = 0 or V <sub>DD</sub> , See Figure 1	4.5	10	19.5	mA
r <sub>O</sub> Output resistance (see Note 4)	V <sub>CC</sub> = V <sub>DD</sub> = V <sub>SS</sub> = 0, V <sub>O</sub> = -2 V to 2 V	300			Ω

- NOTES: 2. The algebraic convention, where the more positive (less negative) limit is designated as maximum, is used in this data sheet for logic levels only (e.g., if -10 V is maximum, the typical value is a more negative voltage).  
 3. Output short-circuit conditions must maintain the total power dissipation below absolute maximum ratings.  
 4. Test conditions are those specified by EIA/TIA-232-E and as listed above.

switching characteristics, V<sub>CC</sub> = 5 V, V<sub>DD</sub> = 12 V, V<sub>SS</sub> = -12 V, T<sub>A</sub> = 25°C

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t <sub>PLH</sub> Propagation delay time, low- to high-level output	R <sub>L</sub> = 3 kΩ to 7 kΩ, C <sub>L</sub> = 15 pF, See Figure 3		315	500	ns
t <sub>PHL</sub> Propagation delay time, high- to low-level output			75	175	ns
t <sub>TLH</sub> Transition time, low- to high-level output	R <sub>L</sub> = 3 kΩ to 7 kΩ, C <sub>L</sub> = 15 pF, See Figure 3		60	100	ns
	R <sub>L</sub> = 3 kΩ to 7 kΩ, C <sub>L</sub> = 2500 pF, See Figure 3 and Note 5		1.7	2.5	μs
t <sub>THL</sub> Transition time, high- to low-level output	R <sub>L</sub> = 3 kΩ to 7 kΩ, C <sub>L</sub> = 15 pF, See Figure 3		40	75	ns
	R <sub>L</sub> = 3 kΩ to 7 kΩ, C <sub>L</sub> = 2500 pF, See Figure 3 and Note 6		1.5	2.5	μs

- NOTES: 5. Measured between -3 V and 3 V points of the output waveform (EIA/TIA-232-E conditions). All unused inputs are tied.  
 6. Measured between 3 V and -3 V points of the output waveform (EIA/TIA-232-E conditions). All unused inputs are tied.

RECEIVER SECTION

electrical characteristics over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
$V_{IT+}$	Positive-going threshold voltage	See Figure 5	$T_A = 25^\circ\text{C}$	1.75	1.9	2.3	V
			$T_A = 0^\circ\text{C to } 70^\circ\text{C}$	1.55		2.3	
$V_{IT-}$	Negative-going threshold voltage			0.75	0.97	1.25	
$V_{hys}$	Input hysteresis ( $V_{IT+} - V_{IT-}$ )			0.5			
$V_{OH}$	High-level output voltage	$I_{OH} = -0.5\text{ mA}$	$V_{IH} = 0.75\text{ V}$	2.6	4	5	V
			Inputs open	2.6			
$V_{OL}$	Low-level output voltage	$I_{OL} = 10\text{ mA}$ ,	$V_I = 3\text{ V}$		0.2	0.45	V
$I_{IH}$	High-level input current	$V_I = 25\text{ V}$ ,	See Figure 5	3.6		8.3	mA
		$V_I = 3\text{ V}$ ,	See Figure 5	0.43			
$I_{IL}$	Low-level input current	$V_I = -25\text{ V}$ ,	See Figure 5	-3.6		-8.3	mA
		$V_I = -3\text{ V}$ ,	See Figure 5	-0.43			
$I_{OS}$	Short-circuit output current				-3.4	-12	mA

† All typical values are at  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $V_{DD} = 9\text{ V}$ , and  $V_{SS} = -9\text{ V}$ .

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $V_{DD} = 12\text{ V}$ ,  $V_{SS} = -12\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$t_{PLH}$	Propagation delay time, low- to high-level output	$C_L = 50\text{ pF}$ , See Figure 6	$R_L = 5\text{ k}\Omega$ ,		107	425	ns
$t_{PHL}$	Propagation delay time, high- to low-level output				42	150	ns
$t_{TLH}$	Transition time, low- to high-level output				175	400	ns
$t_{THL}$	Transition time, high- to low-level output				16	60	ns

PARAMETER MEASUREMENT INFORMATION

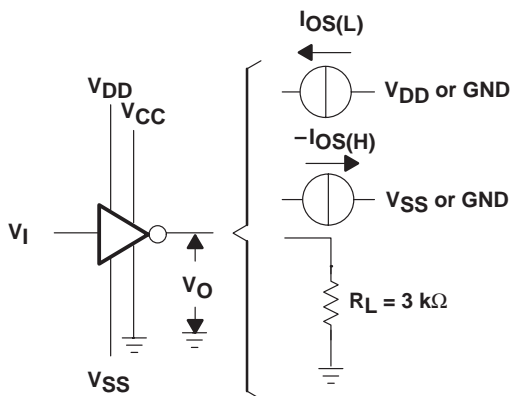


Figure 1. Driver Test Circuit for  $V_{OH}$ ,  $V_{OL}$ ,  $I_{OS(H)}$ , and  $I_{OS(L)}$

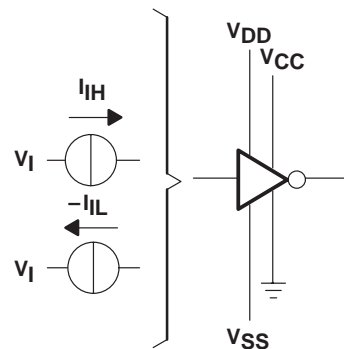
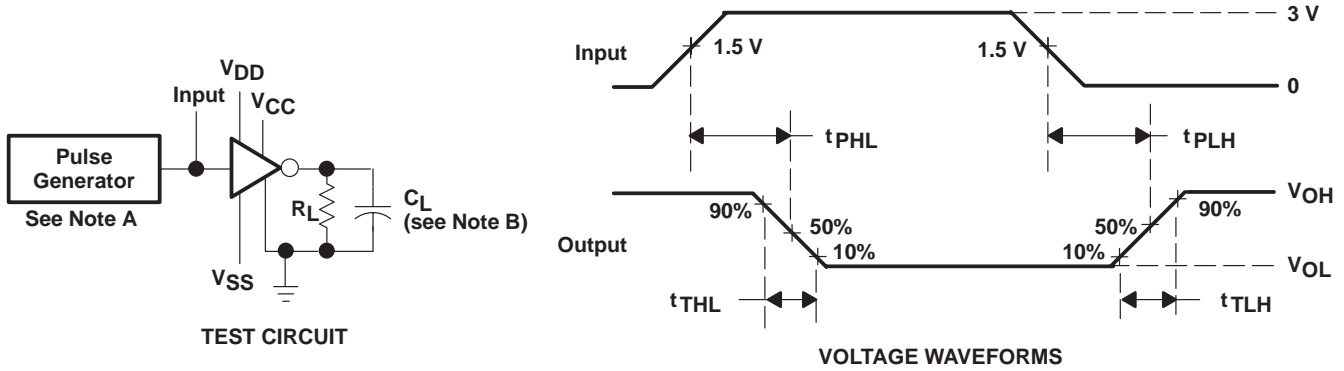


Figure 2. Driver Test Circuit for  $I_{IH}$  and  $I_{IL}$

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## PARAMETER MEASUREMENT INFORMATION



NOTES: A. The pulse generator has the following characteristics:  $t_w = 25 \mu s$ ,  $PRR = 20 \text{ kHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r = t_f < 50 \text{ ns}$ .  
B.  $C_L$  includes probe and jig capacitance.

Figure 3. Driver Test Circuit and Voltage Waveforms

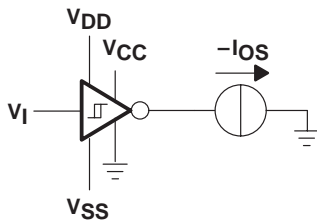


Figure 4. Receiver Test Circuit for  $I_{OS}$

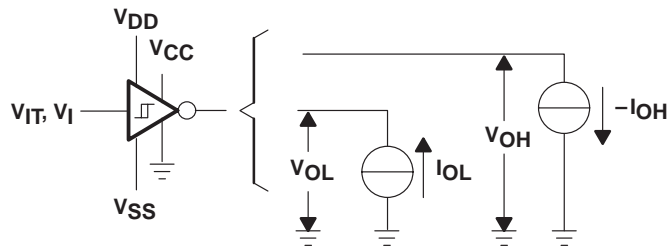
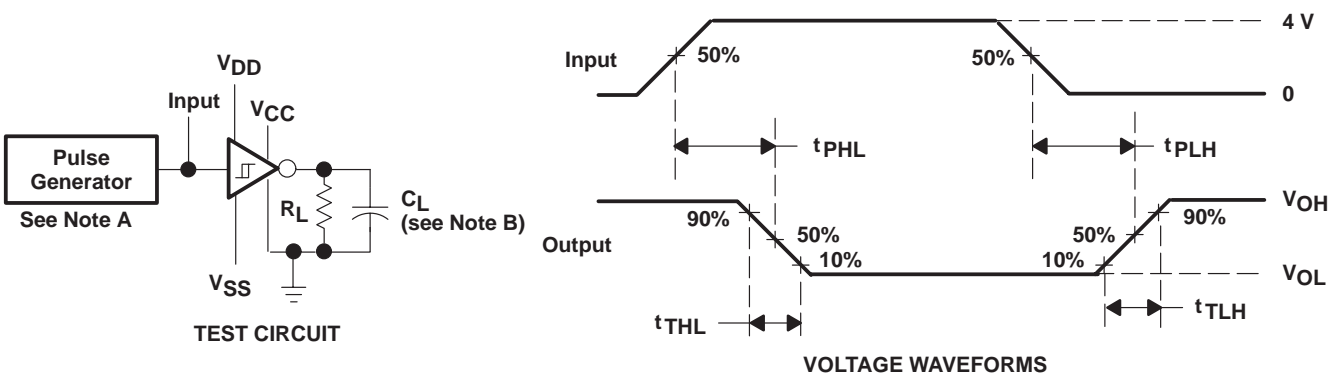


Figure 5. Receiver Test Circuit for  $V_{IT}$ ,  $V_{OH}$ , and  $V_{OL}$



NOTES: A. The pulse generator has the following characteristics:  $t_w = 25 \mu s$ ,  $PRR = 20 \text{ kHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r = t_f < 50 \text{ ns}$ .  
B.  $C_L$  includes probe and jig capacitance.

Figure 6. Receiver Propagation and Transition Times

TYPICAL CHARACTERISTICS

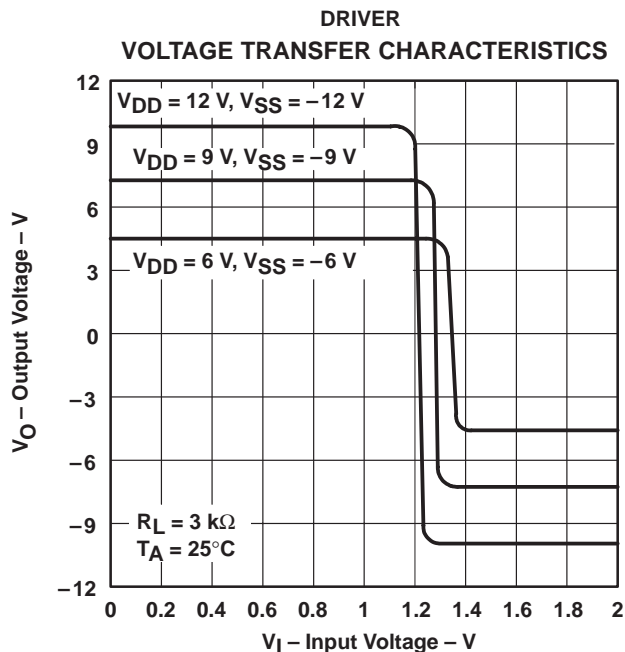


Figure 7

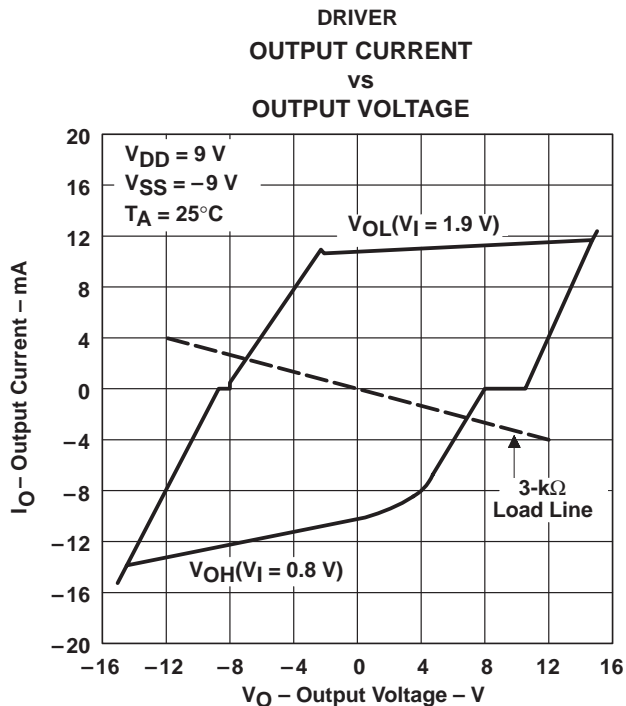


Figure 8

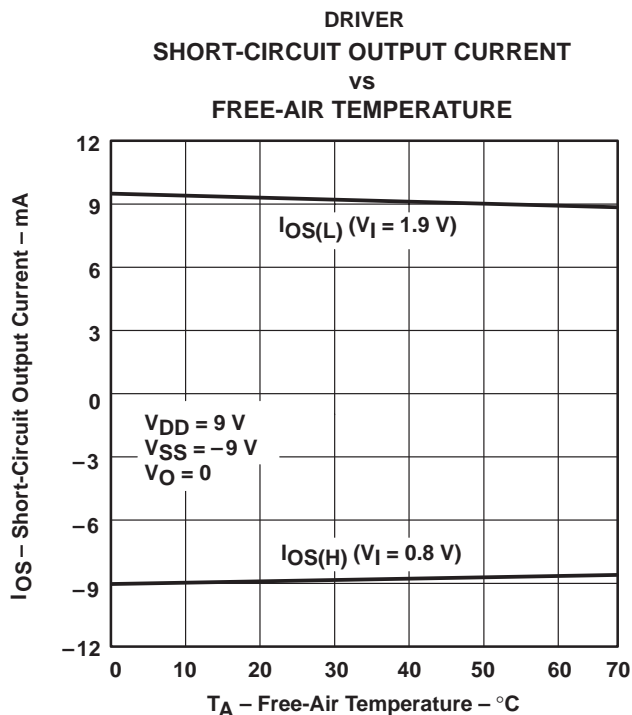


Figure 9

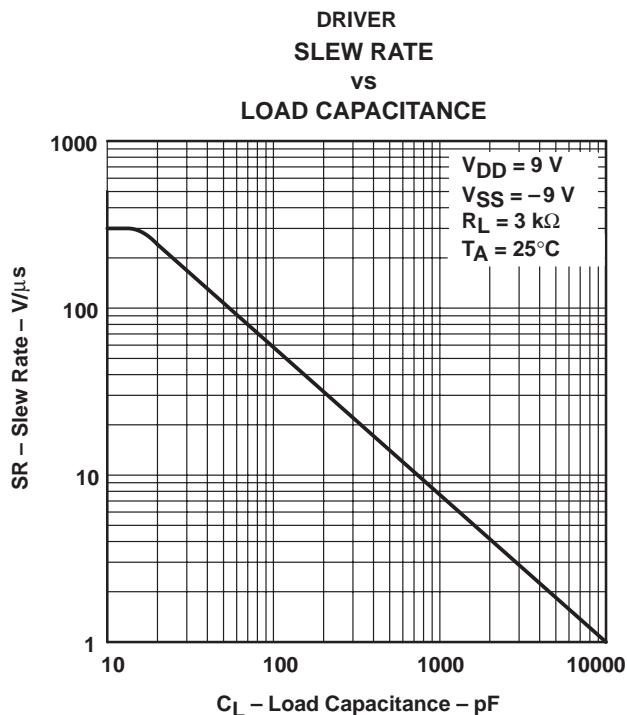


Figure 10

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## TYPICAL CHARACTERISTICS

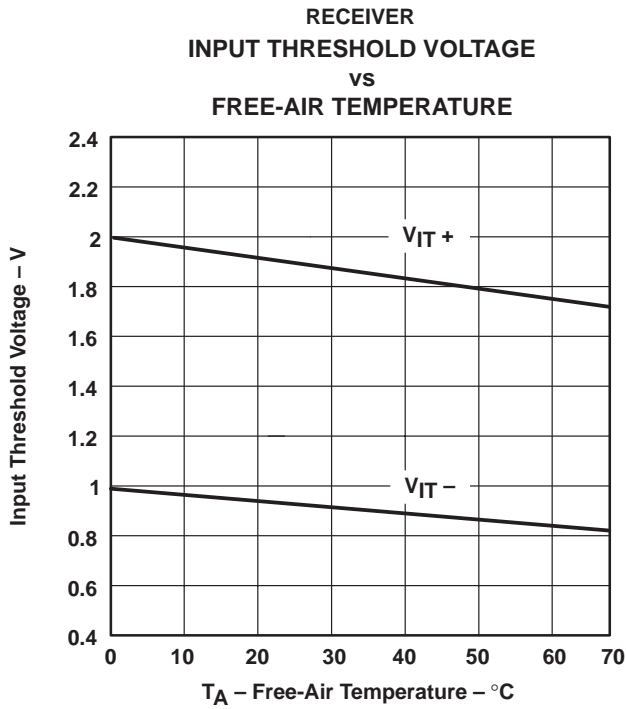


Figure 11

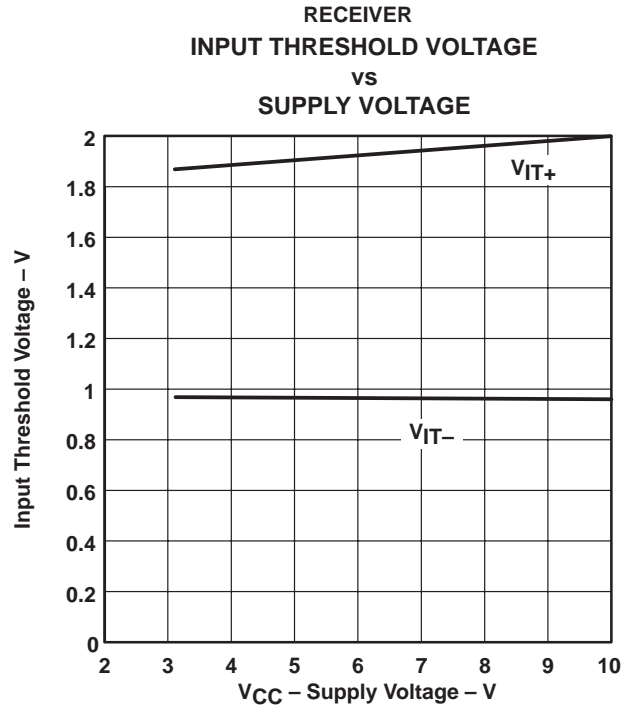
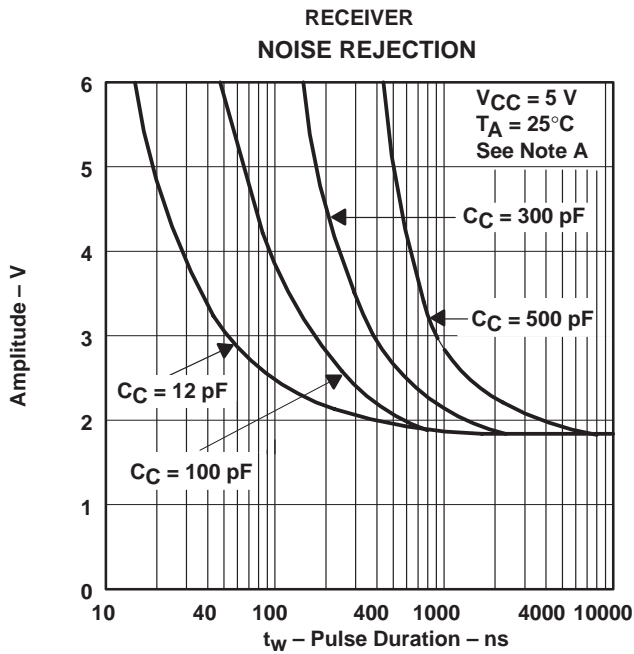


Figure 12



NOTE A: This figure shows the maximum amplitude of a positive-going pulse that, starting from 0, does not cause a change of the output level.

Figure 13

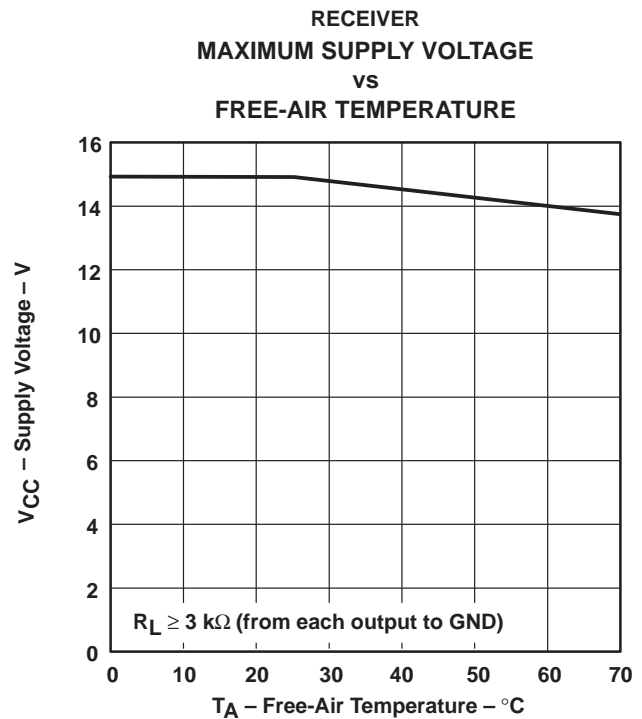
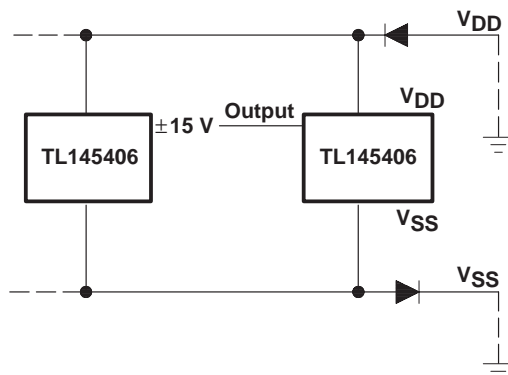


Figure 14



**APPLICATION INFORMATION**

Diodes placed in series with the  $V_{DD}$  and  $V_{SS}$  leads protect the TL145406 during the fault condition in which the device outputs are shorted to  $\pm 15$  V and the power supplies are at low. Diodes also provide low-impedance paths to ground (see Figure 15).



**Figure 15. Power-Supply Protection to Meet Power-Off Fault Conditions of ANSI EIA/TIA-232-E**

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