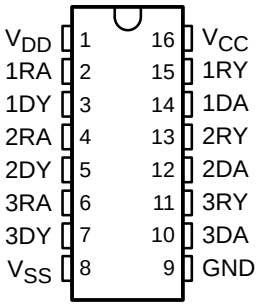
TL145406
TRIPLE RS-232 DRIVERS/RECEIVERS

SLLS185D – DECEMBER 1994 – REVISED JULY 2001

- **Meets or Exceeds the Requirements of ANSI TIA/EIA-232-F and ITU V.28**
- **Designed to Support Data Rates up to 120 kbit/s Over 3-m Cable**
- **ESD Protection Exceeds 5 kV on All Pins**
- **Flow-Through Design**
- **Wide-Driver Supply Voltage . . . ±7.5 V to ±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 to 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 TIA/EIA-232-F and ITU (formerly CCITT) V.28 standards. These standards are for data interchange between a host computer and peripheral at signaling 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 signaling rates cannot be assured unless the designer has design control of the cable and of the interface circuits at both ends. For interoperability at signaling rates to 120 kbit/s, use of TIA/EIA-423-B (ITU V.10) and TIA/EIA-422-B (ITU V.11) standards is recommended.

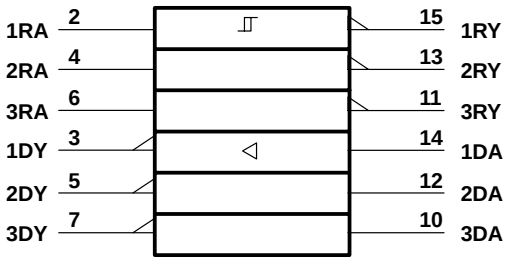
The TL145406 is characterized for operation from 0°C to 70°C.

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES	
	PLASTIC DIP (N)	PLASTIC SMALL OUTLINE (DW)
0°C to 70°C	TL145406N	TL145406DW

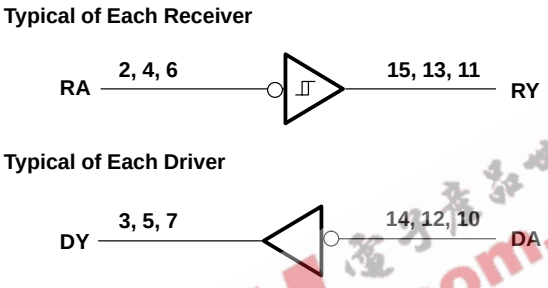
The DW package also is available taped and reeled. Add the suffix R to the device type (e.g., TL145406DWR).

logic symbol†

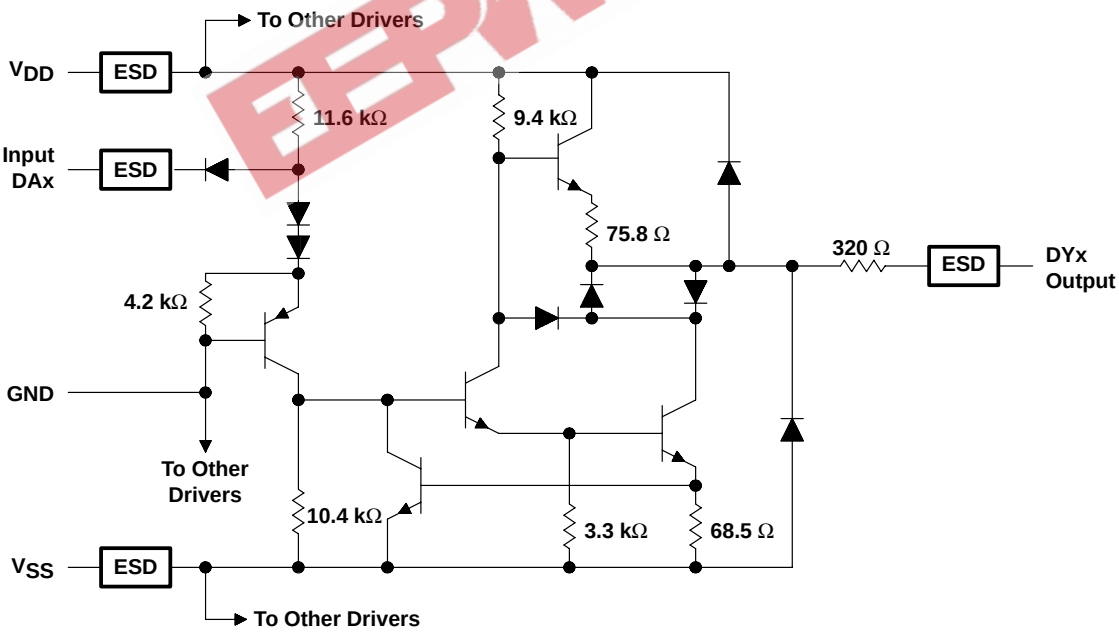


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

logic diagram (positive logic)

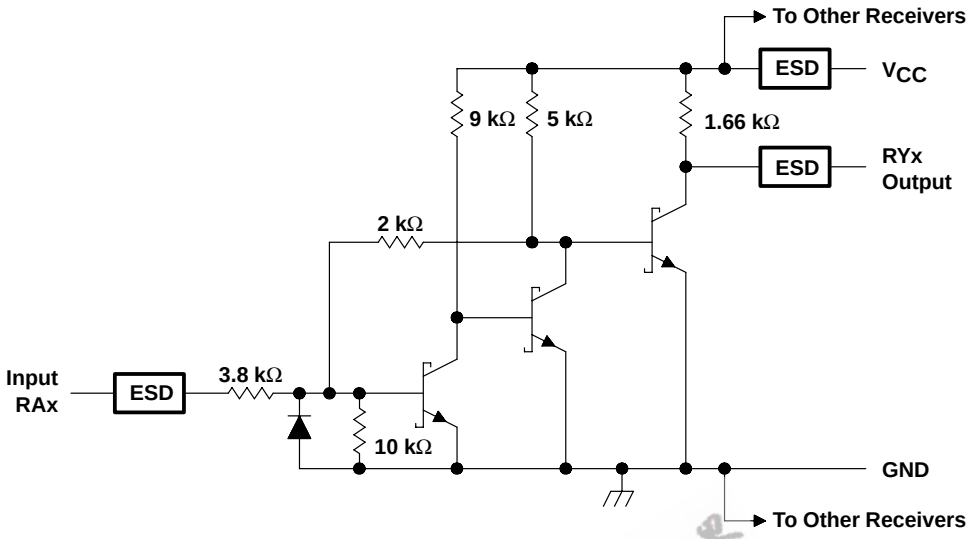


schematic (each driver)



Resistor values shown are nominal.

schematic (each receiver)



Resistor values shown are nominal.

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

Supply voltage (see Note 1):	V_{CC}	10 V
	V_{DD}	15 V
	V_{SS}	–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
Package thermal impedance, θ_{JA} (see Note 2):	DW package	57°C/W
	N package	67°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 51-7.

recommended operating conditions

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

supply currents

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
I_{DD}	Supply current from V_{DD}	All inputs at 1.9 V,	No load	V_{DD} = 9 V, V_{SS} = –9 V			15	mA
				V_{DD} = 12 V, V_{SS} = –12 V			19	
				V_{DD} = 15 V, V_{SS} = –15 V			25	
		All inputs at 0.8 V,	No load	V_{DD} = 9 V, V_{SS} = –9 V			4.5	
				V_{DD} = 12 V, V_{SS} = –12 V			5.5	
				V_{DD} = 15 V, V_{SS} = –15 V			9	
I_{SS}	Supply current from V_{SS}	All inputs at 1.9 V,	No load	V_{DD} = 9 V, V_{SS} = –9 V			–15	mA
				V_{DD} = 12 V, V_{SS} = –12 V			–19	
				V_{DD} = 15 V, V_{SS} = –15 V			–25	
		All inputs at 0.8 V,	No load	V_{DD} = 9 V, V_{SS} = –9 V			–3.2	
				V_{DD} = 12 V, V_{SS} = –12 V			–3.2	
				V_{DD} = 15 V, V_{SS} = –15 V			–3.2	
I_{CC}	Supply current from V_{CC}	All inputs at 5 V,	No load,	V_{CC} = 5 V		13.2	20	mA

DRIVER SECTION

electrical characteristics over recommended operating free-air temperture range, V_{DD} = 9 V, V_{SS} = −9 V, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
V_{OH}	High-level output voltage	V_{IL} = 0.8 V,	R_L = 3 kΩ,	See Figure 1	6	7.5		V
V_{OL}	Low-level output voltage (see Note 3)	V_{IH} = 1.9 V,	R_L = 3 kΩ,	See Figure 1		–7.5	–6	V
I_{IH}	High-level input current	V_I = 5 V,	See Figure 2				10	µA
I_{IL}	Low-level input current	V_I = 0,	See Figure 2				–1.6	mA
$I_{OS(H)}$	High-level short-circuit output current (see Note 4)	V_{IL} = 0.8 V,	V_O = 0 or V_{SS},	See Figure 1	–4.5	–10	–19.5	mA
$I_{OS(L)}$	Low-level short-circuit output current	V_{IH} = 2 V,	V_O = 0 or V_{DD},	See Figure 1	4.5	10	19.5	mA
r_O	Output resistance (see Note 5)	V_{CC} = V_{DD} = V_{SS} = 0, V_O = –2 V to 2 V			300			Ω

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 (e.g., if –10 V is maximum, the typical value is a more negative voltage).
4. Output short-circuit conditions must maintain the total power dissipation below absolute maximum ratings.
5. Test conditions are those specified by TIA/EIA-232-F and as listed above.

switching characteristics, V_{CC} = 5 V, V_{DD} = 12 V, V_{SS} = –12 V, T_A = 25°C

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		315	500	ns
t_{PHL}	Propagation delay time, high- to low-level output	R_L = 3 kΩ to 7 kΩ, C_L = 15 pF, See Figure 3		75	175	ns
t_{TLH}	Transition time, low- to high-level output	R_L = 3 kΩ to 7 kΩ, C_L = 15 pF, See Figure 3		60	100	ns
		R_L = 3 kΩ to 7 kΩ, C_L = 2500 pF, See Figure 3 and Note 6		1.7	2.5	µs
t_{THL}	Transition time, high- to low-level output	R_L = 3 kΩ to 7 kΩ, C_L = 15 pF, See Figure 3		40	75	ns
		R_L = 3 kΩ to 7 kΩ, C_L = 2500 pF, See Figure 3 and Note 7		1.5	2.5	µs

NOTES: 6. Measured between –3-V and 3-V points of the output waveform (TIA/EIA-232-F conditions). All unused inputs are tied.
7. Measured between 3-V and –3-V points of the output waveform (TIA/EIA-232-F 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°C	1.75	1.9	2.3	V
			T_A = 0°C to 70°C	1.55		2.3	
V_{IT-}	Negative-going threshold voltage			0.75	0.97	1.25	V
V_{hys}	Input hysteresis ($V_{IT+} - V_{IT-}$)			0.5			V
V_{OH}	High-level output voltage	I_{OH} = –0.5 mA	V_{IH} = 0.75 V	2.6	4	5	V
			Inputs open	2.6			
V_{OL}	Low-level output voltage	I_{OL} = 10 mA,	V_I = 3 V		0.2	0.45	V
I_{IH}	High-level input current	V_I = 25 V,	See Figure 5	3.6		8.3	mA
		V_I = 3 V,	See Figure 5	0.43			
I_{IL}	Low-level input current	V_I = –25 V,	See Figure 5	–3.6		–8.3	mA
		V_I = –3 V,	See Figure 5	–0.43			
I_{OS}	Short-circuit output current				–3.4	–12	mA

† All typical values are at T_A = 25°C, V_{CC} = 5, V_{DD} = 9 V, and V_{SS} = –9 V.

switching characteristics, V_{CC} = 5 V, V_{DD} = 12 V, V_{SS} = –12 V, T_A = 25°C

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		107	425	ns
t_{PHL}	Propagation delay time, high- to low-level output	C_L = 50 pF,	R_L = 5 kΩ,	See Figure 6		42	150	ns
t_{TLH}	Transition time, low- to high-level output	C_L = 50 pF,	R_L = 5 kΩ,	See Figure 6		175	400	ns
t_{THL}	Transition time, high- to low-level output	C_L = 50 pF,	R_L = 5 kΩ,	See Figure 6		16	60	ns

PARAMETER MEASUREMENT INFORMATION

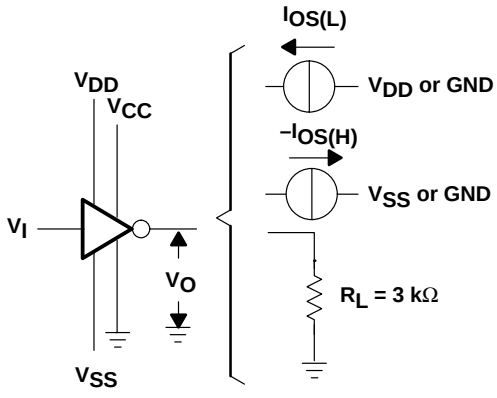


Figure 1. Driver Test Circuit for V_{OH}, V_{OL}, $I_{OS(H)}$, and $I_{OS(L)}$

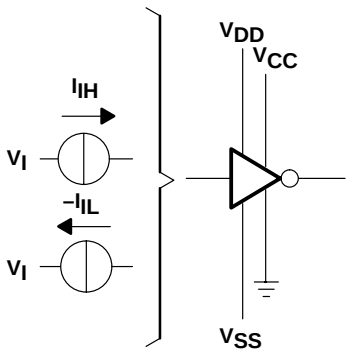
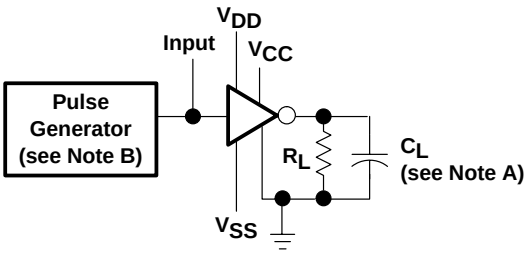
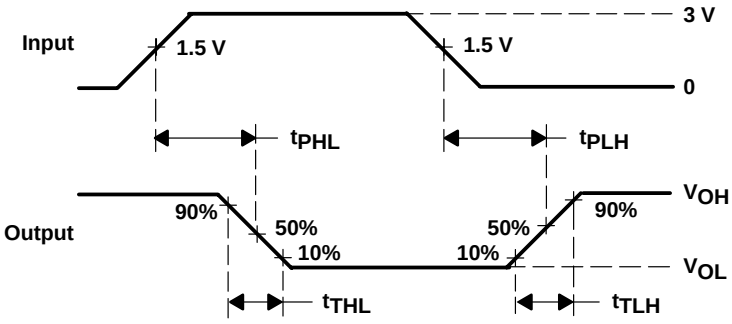


Figure 2. Driver Test Circuit for I_{IH} and I_{IL}

PARAMETER MEASUREMENT INFORMATION



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

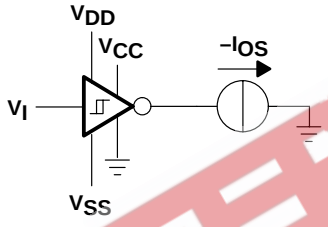


Figure 4. Receiver Test Circuit for I_{OS}

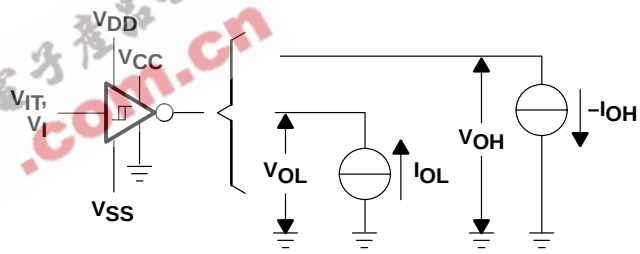
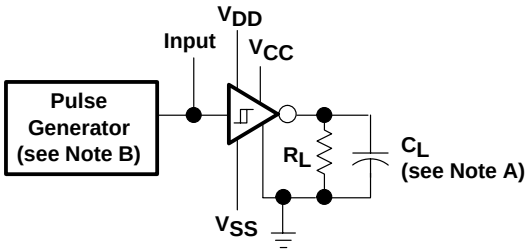
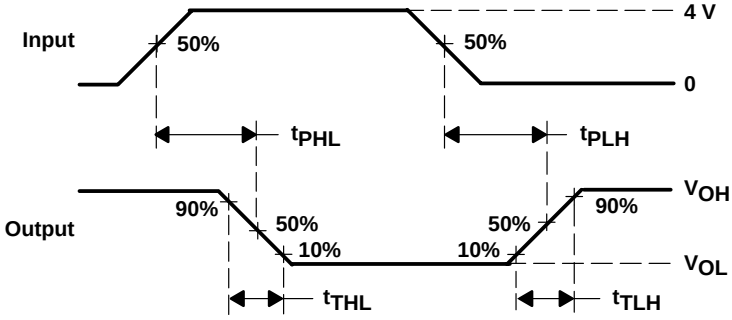


Figure 5. Receiver Test Circuit for V_{IT}, V_{OH}, and V_{OL}



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 6. Receiver Propagation and Transition Times

TYPICAL CHARACTERISTICS

DRIVER
VOLTAGE TRANSFER CHARACTERISTICS

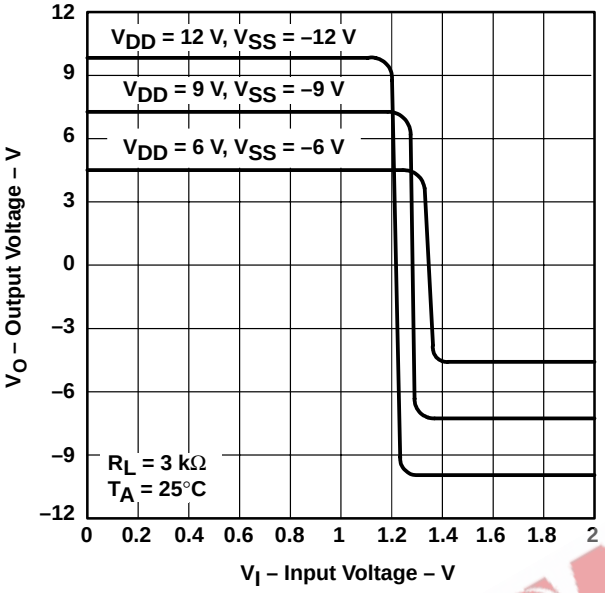


Figure 7

DRIVER
OUTPUT CURRENT
vs
OUTPUT VOLTAGE

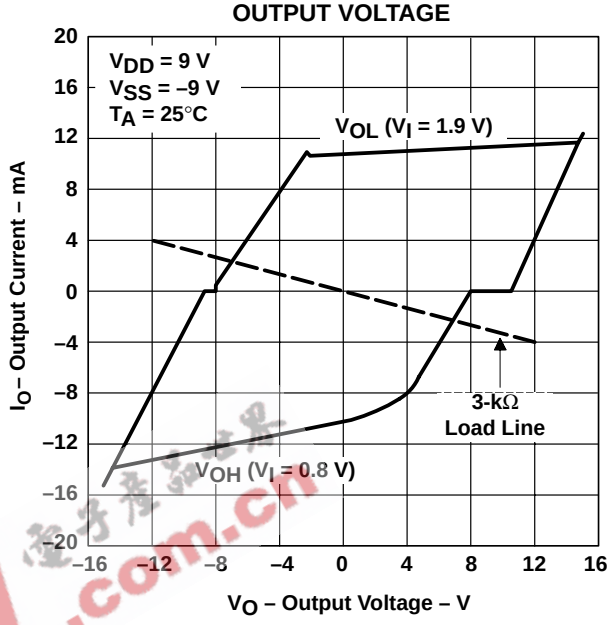


Figure 8

DRIVER
SHORT-CIRCUIT OUTPUT CURRENT
vs
FREE-AIR TEMPERATURE

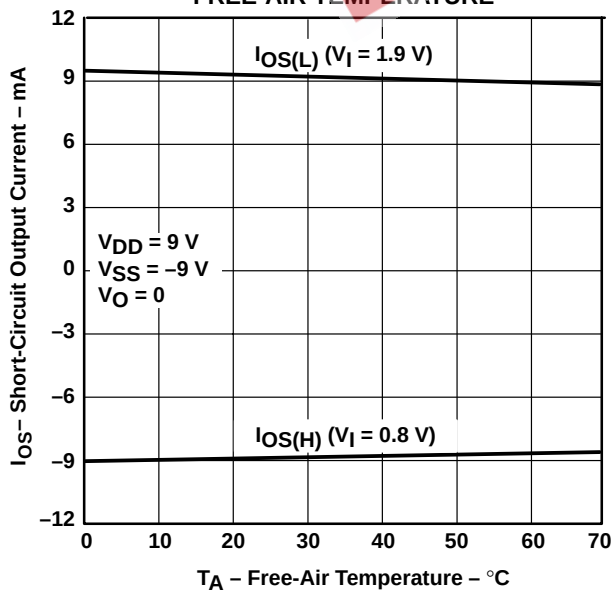


Figure 9

DRIVER
SLEW RATE
vs
LOAD CAPACITANCE

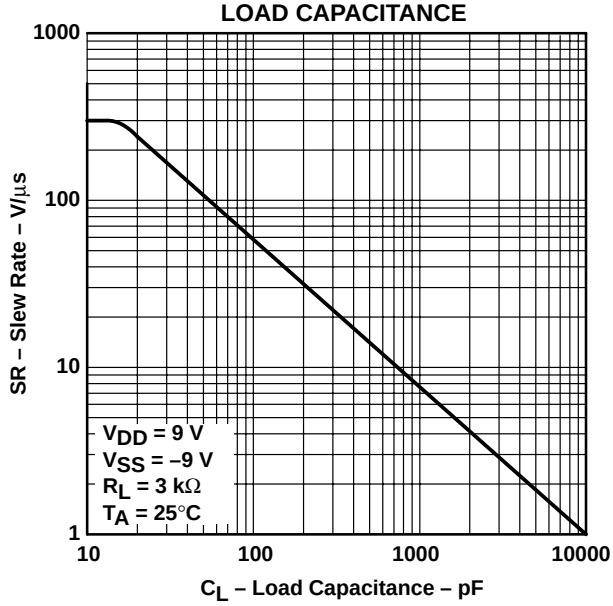


Figure 10

TYPICAL CHARACTERISTICS

RECEIVER
INPUT THRESHOLD VOLTAGE
vs
FREE-AIR TEMPERATURE

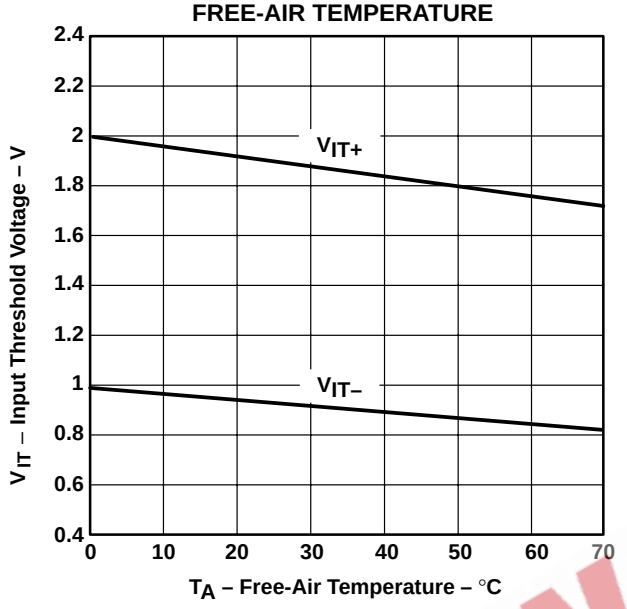


Figure 11

RECEIVER
INPUT THRESHOLD VOLTAGE
vs
SUPPLY VOLTAGE

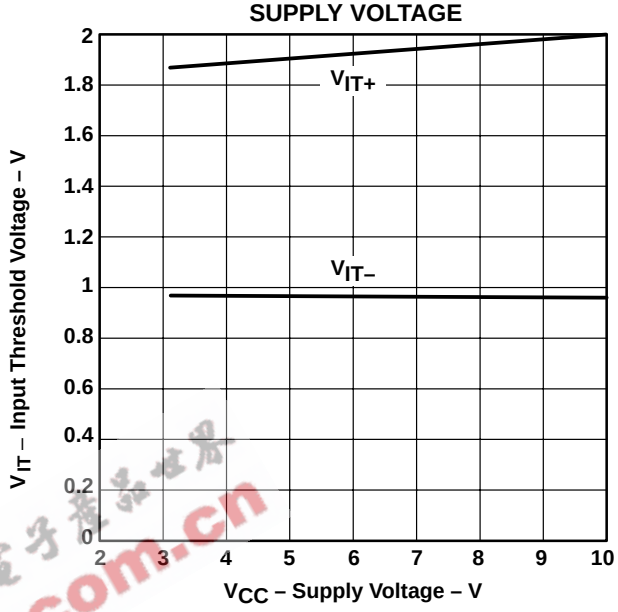
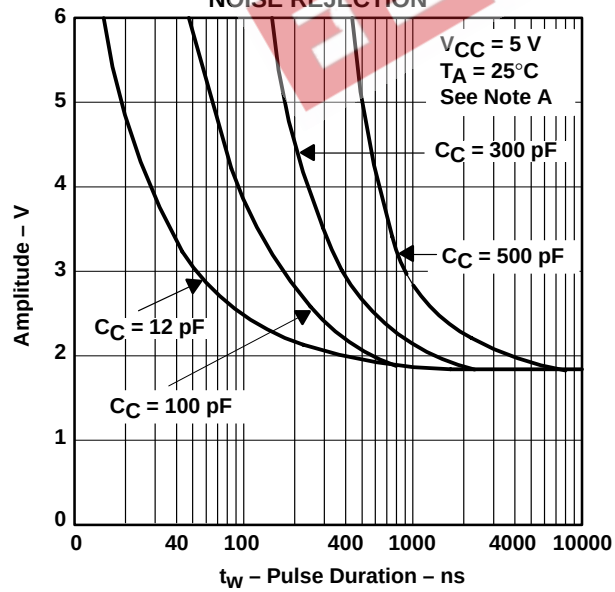


Figure 12

RECEIVER
NOISE REJECTION



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

RECEIVER
MAXIMUM SUPPLY VOLTAGE
vs
FREE-AIR TEMPERATURE

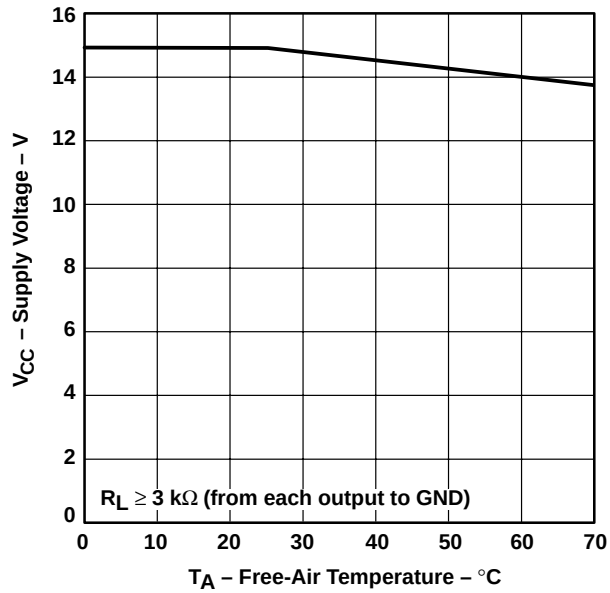


Figure 14

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 ±15 V and the power supplies are at low. Diodes also provide low-impedance paths to ground (see Figure 15).

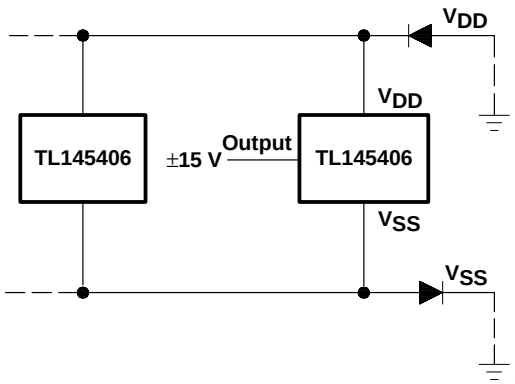


Figure 15. Power-Supply Protection to Meet Power-Off Fault Conditions of ANSI TIA/EIA-232-F

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TL145406DW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL145406DWE4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL145406DWR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL145406DWRE4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL145406N	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL145406NE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

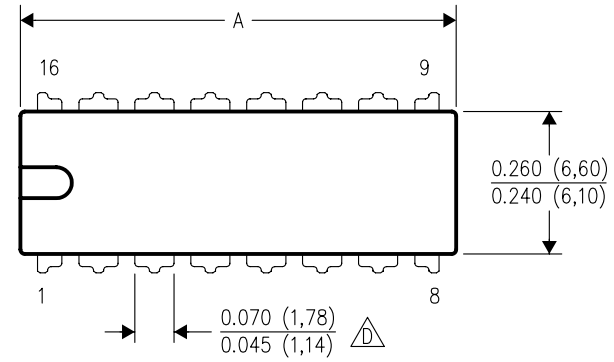
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

N (R–PDIP–T**)

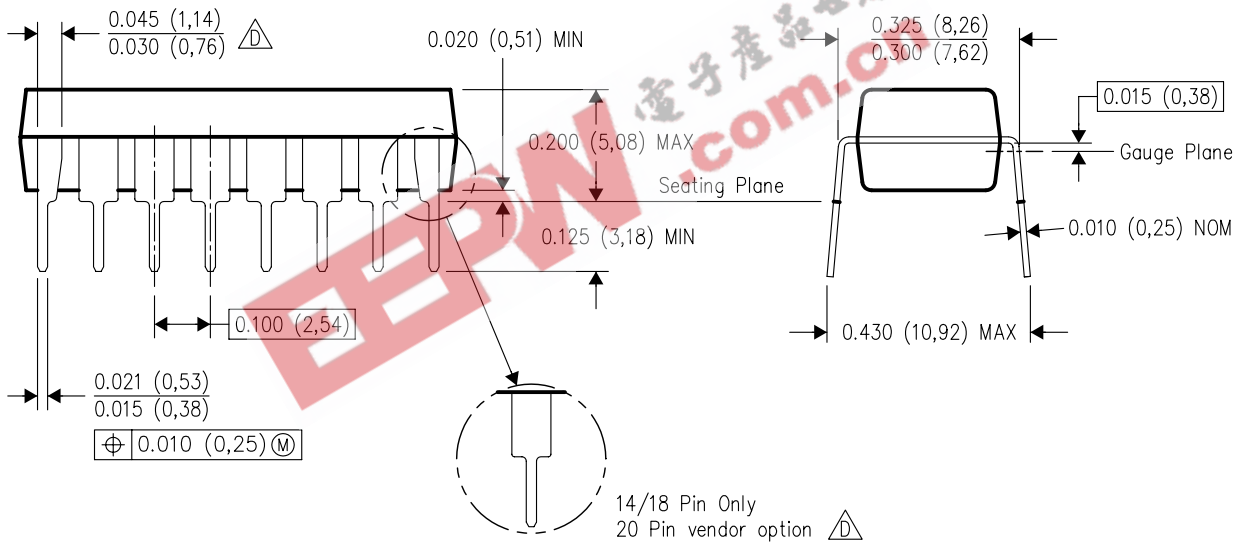
PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION	AA	BB	AC	AD

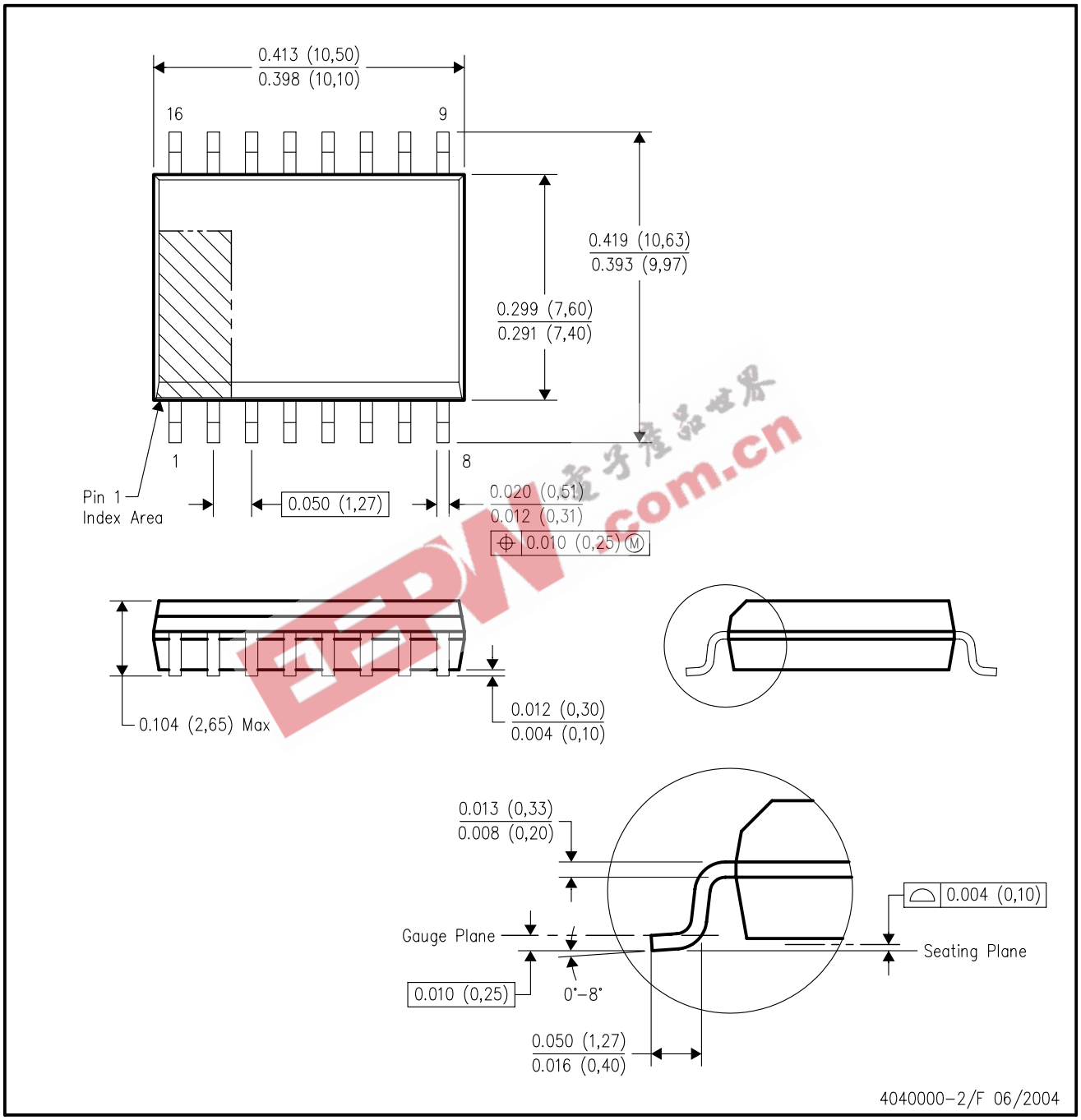
C



4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

DW (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–013 variation AA.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265