Overvoltage Fault Protected CAN Transceiver

FEATURES

- **Protected from Overvoltage Line Faults to ±60V**
- **ESD Protection to IEC-1000-4-2 Level 4**
  ±15kV Air Gap Test
  ±8kV Contact Mode Test
- **ISO 11898 Compatible**
- High Input Impedance Supports Up to 256 Nodes
- Controlled Slew Rates for EMI Emissions Control
- High Impedance Outputs When Off or Powered Down
- Short-Circuit Protection On All Outputs
- Thermal Shutdown Protection
- Pin Compatible with Philips PCA82C251

APPLICATIONS

- Industrial Control Data Networks
- Automotive Systems
- HVAC Controls

DESCRIPTION

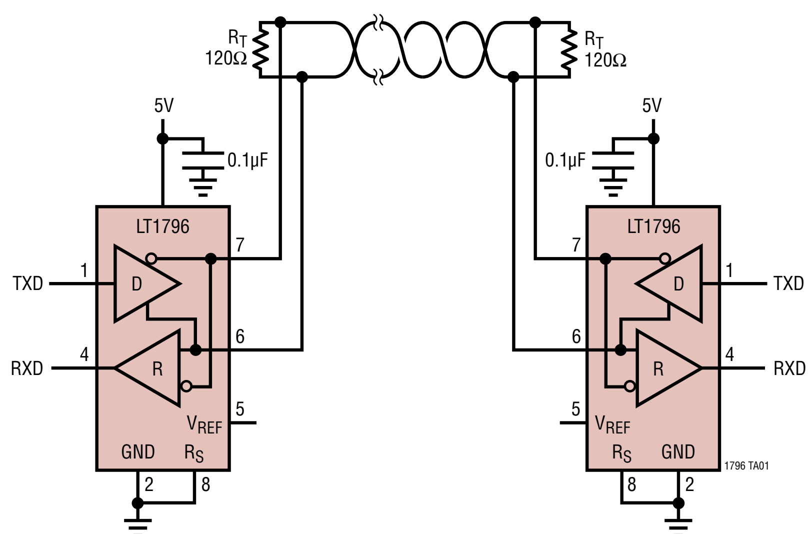
The LT®1796 CAN transceiver provides built-in fault tolerance to survive in industrial and automotive environments. Discrete protection devices are not needed. Bus interface pins can withstand voltage faults up to ±60V with respect to ground with no damage to the device. Faults may occur while the transceiver is active, shut down or powered off. On-chip ESD protection withstands up to ±15kV air discharges and ±8kV contact mode discharges tested per IEC-1000-4-2. Loss of power or ground connections does not damage the IC.

The circuit operates with data rates up to 125kbaud. A slew control pin allows control of transmitted data pulse edges to control EMI and reflection problems on imperfectly terminated lines. High output current drive allows the use of inexpensive PVC cable with impedance as low as 72Ω. The 100kΩ input impedance allows up to 256 transceivers per data network.

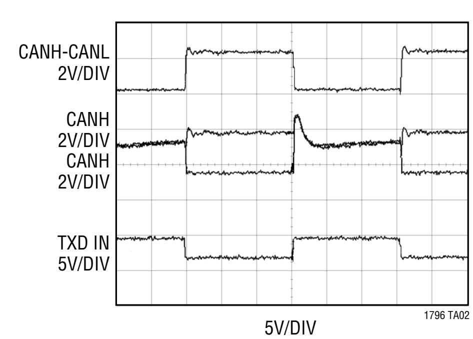
The LT1796 is available in 8-lead PDIP and SO packages.

TYPICAL APPLICATION

Fault Protected CAN Bus Network



125kbps CANH and CANL Driver Output



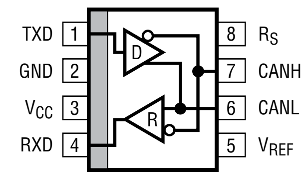
ABSOLUTE MAXIMUM RATINGS

(Note 1)

Supply Voltage (V_{CC}) 44V
R_S Slope Control Input Voltage .... −0.3V to 44V
V_{REF} Reference Output Pin......................... −0.3V to 7V
Driver Input Voltage .... −0.3V to 44V
CANH, CANL Data Line Pins....................... −80V to 80V
Receiver Output Voltages............................ −0.3V to 7V
Operating Temperature Range
LT1796C.. 0°C to 70°C
LT1796I.. −40°C to 85°C
Storage Temperature Range ....−65°C to 150°C
Lead Temperature (Soldering, 10 sec)...................300°C

PIN CONFIGURATION

TOP VIEW



N8 PACKAGE 8-LEAD PDIP S8 PACKAGE 8-LEAD PLASTIC SO

T_{JMAX} = 150°C, θ_{JA} = 130°C/W (N8)
T_{JMAX} = 150°C, θ_{JA} = 150°C/W (S8)

ORDER INFORMATION

LEAD FREE FINISH	TAPE AND REEL	PART MARKING*	PACKAGE DESCRIPTION	TEMPERATURE RANGE
LT1796CN8#PBF	LT1796CN8#TRPBF	LT1796 CN8	8-Lead PDIP	0°C to 70°C
LT1796CS8#PBF	LT1796CS8#TRPBF	1796	8-Lead Plastic SO	0°C to 70°C
LT1796IN8#PBF	LT1796IN8#TRPBF	LT1796I IN8	8-Lead PDIP	–40°C to 85°C
LT1796IS8#PBF	LT1796IS8#TRPBF	1796I	8-Lead Plastic SO	–40°C to 85°C

Consult LTC Marketing for parts specified with wider operating temperature ranges. *The temperature grade is identified by a label on the shipping container.

Consult LTC Marketing for information on nonstandard lead based finish parts.

For more information on lead free part marking, go to: http://www.linear.com/leadfree/
For more information on tape and reel specifications, go to: http://www.linear.com/tapeandreel/

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_{CC} = 4.75V to 5.25V, V_{RS} = 0V unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{CANH}	CANH Output Voltage	V_{TXD} = 0V, No Load	●	3.8	4.4	5.0	V
		V_{TXD} = 0V, R_L = 60Ω	●	2.8	3.5	4.6	V
V_{CANL}	CANL Output Voltage	V_{TXD} = 0V, No Load	●	0	0.5	0.9	V
		V_{TXD} = 0V, R_L = 60Ω	●	0	1.3	1.6	V
V_{OD}	Dominant State Differential Output Voltage	V_{TXD} = 0V, No Load, V_{CC} = 4.75V	●	3.0	3.6	5.0	V
		V_{TXD} = 0V, R_L = 60Ω, V_{CC} = 4.75V	●	1.5	2.0	4.2	V
		V_{TXD} = 0V, R_L = 36Ω, V_{CC} = 4.75V	●	1.2	1.7	4.2	V
V_{REC}	Recessive State Differential Output Voltage	V_{TXD} = 5V, R_L = 60Ω	●	–10	0	10	mV
V_{CMR}	Recessive State Common Mode Output Voltage	V_{TXD} = 5V, R_L = 60Ω, V_{CC} = 5V	●	2.7	3	3.5	V

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_{CC} = 4.75V to 5.25V, V_{RS} = 0V unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{CMD}	Dominant State Common Mode Output Voltage	R_L = 60Ω, V_{CC} = 5V	●	2	2.5	3	V
V_{IH}	TXD Input High Voltage		●	2.8			V
V_{IL}	TXD Input Low Voltage		●			2	V
I_{IN1}	TXD Input Current	0 < V_{TXD} < V_{CC}	●	–5		5	µA
I_{SCH}	CANH Short-Circuit Current, Dominant Mode	V_{CANH} = 0V, V_{CC} = 5.25V V_{CANH} = –36V, V_{CC} = 5.25V V_{CANH} = –60V, V_{CC} = 5.25V V_{CANH} = 60V, V_{CC} = 5.25V	● ● ● ●	–250 –10 –10 0	 –1 –1 1	–60 0 0 10	mA mA mA mA
I_{SCL}	CANL Short-Circuit Current, Dominant Mode	V_{CANL} = 5V, V_{TXD} = 0V, V_{CC} = 5.25V V_{CANL} = 36V, V_{TXD} = 0V, V_{CC} = 5.25V V_{CANL} = 60V, V_{TXD} = 0V, V_{CC} = 5.25V V_{CANL} = –60V, V_{TXD} = 0V, V_{CC} = 5.25V	● ● ● ●	60 0 0 –10	 1 1 –1	250 10 10 0	mA mA mA mA
R_{IND}	Differential Input Resistance	V_{TXD} = 5V, –7V < V_{CANH}, V_{CANL} < 12V	●	140	240	350	kΩ
	CANH, CANL Input Resistance	V_{TXD} = 5V, –7V < V_{CANH}, V_{CANL} < 12V	●	70	120	175	kΩ
	Input Fault Current (CANH, CANL)	V_{RS} = 5V, –60V < V_{CANH}, V_{CANL} < 60V V_{TXD} = 5V, –60V < V_{CANH}, V_{CANL} < 60V V_{CC} = 0V, –60V < V_{CANH}, V_{CANL} < 60V	● ● ●	–3 –3 –3		3 3 3	mA mA mA

DC ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_{CC} = 4.75V to 5.25V, V_{RS} = 0V unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{TH}	Differential Input Threshold Voltage for Receiver	V_{RS} = 0V, –7V < V_{CM} < 12V V_{RS} = 5V, –7V < V_{CM} < 12V	● ●	0.5 0.5		0.9 0.9	V V
ΔV_{TH}	Receiver Input Hysteresis	–7V < V_{CM} < 12V			70		mV
V_{OH}	Receiver Output High Voltage	V_{CC} = 4.75V, I_O = –400µA, V_{ID} = 500mV	●	3	3.6		V
V_{OL}	Receiver Output Low Voltage	V_{CC} = 4.75V, I_O = 1.6mA, V_{ID} = 900mV	●		0.15	0.4	V
I_{SCR}	Receiver Short-Circuit Current	0V < V_O < V_{CC} , V_{CC} = 5.25V	●	7	20	85	mA
V_{REF}	Reference Output Voltage	–100µA < I_{REF} < 100µA	●	2.25	2.5	2.7	V
V_{REFSC}	Reference Output Short-Circuit Current	0 < V_{REF} < V_{CC}	●	–20		20	mA
V_{RSSB}	R_S Pin Standby Threshold	V_{CC} = 5V	●	2.5	2.8	4	V
I_{RS}	R_S Input Current	V_{RS} = 5V, V_{CC} = 5V V_{RS} = 0V, V_{CC} = 5V R_S = 47k, V_{CC} = 5V	● ● ●	–270 –90	0.1 –200 –60	10 –140 –40	µA µA µA
I_{CC}	Supply Current Dominant Recessive Standby	No Load, V_{RS} = 0V, V_{TXD} = 0V, V_{CC} = 5.25V R_L = 60Ω, V_{RS} = 0V, V_{TXD} = 5V, V_{CC} = 5.25V R_L = 60Ω, V_{RS} = 5V, V_{CC} = 5.25V	● ● ●		4.3 3.8 0.8	7 7 1.5	mA mA mA

SWITCHING CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range. V_{RS} = 0V unless otherwise noted. (Note 2)

SYMBOL	PARAMETER	CONDITIONS			MIN	TYP	MAX	UNITS
t_{BIT}	Minimum Bit Time	(Note 3)		●			8	µs
F_{MAX}	Maximum Data Rate	(Note 3)		●	125			kbps
t_{TXDON}	Driver Input to Bus Active	Figures 1, 2	R_S = 0k	●		300	500	ns
			R_S = 47k	●		350	1000	ns
t_{TXDOFF}	Driver Input to Bus Inactive	Figures 1, 2	R_S = 0k	●		500	1200	ns
			R_S = 47k	●		600	1500	ns
t_{LBON}	Loopback Delay Active	Figures 1, 3		●		0.6	1.5	µs
t_{LBOFF}	Loopback Delay Inactive	Figures 1, 3		●		1.5	3	µs
t_{RXDOFF}	Receiver Delay Off	Figures 1, 4		●		400	600	ns
t_{RXDON}	Receiver Delay On	Figures 1, 4		●		300	600	ns
$t_{RXDOFFSB}$	Receiver Delay Off, Standby	V_{RS} = 4V, Figures 1, 4		●		1.5	4	µs
$t_{RXDONSB}$	Receiver Delay On, Standby	V_{RS} = 4V, Figures 1, 4		●		1	4	µs
t_{WAKE}	Wake-Up Delay from Standby	Figures 1, 5		●		1	15	µs
SR^+	Positive Slew Rate	R_S = 0k R_S = 47k		● ●	5 2	12 7	65 30	V/µs V/µs
SR^-	Negative Slew Rate	R_S = 0k R_S = 47k		● ●	5 2	36 5	65 15	V/µs V/µs

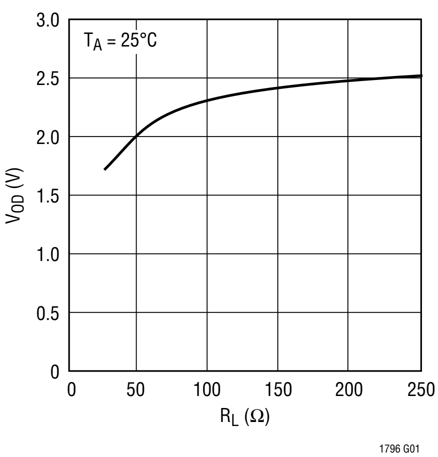
Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: Unless otherwise specified, testing done at V_{CC} = 5V, T_A = 25°C.

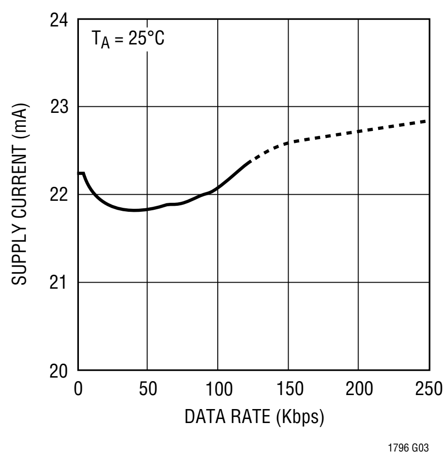
Note 3: Bit time and data rate specifications are guaranteed by driver and receiver delay time measurements.

TYPICAL PERFORMANCE CHARACTERISTICS

Dominant State Bus Voltage vs R_L

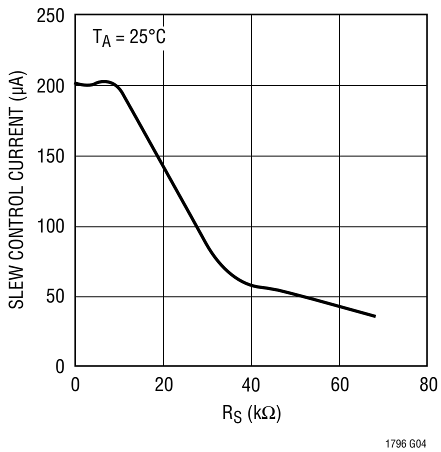


Supply Current vs Data Rate Transmitting, 50% Duty Cycle

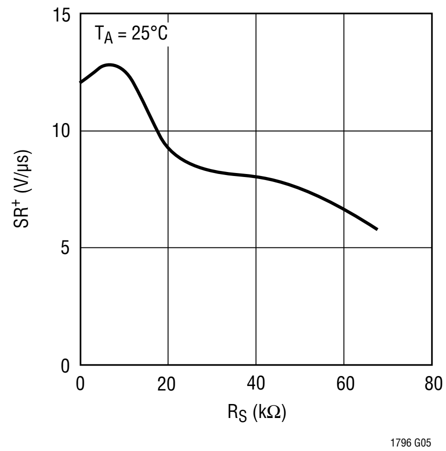


TYPICAL PERFORMANCE CHARACTERISTICS

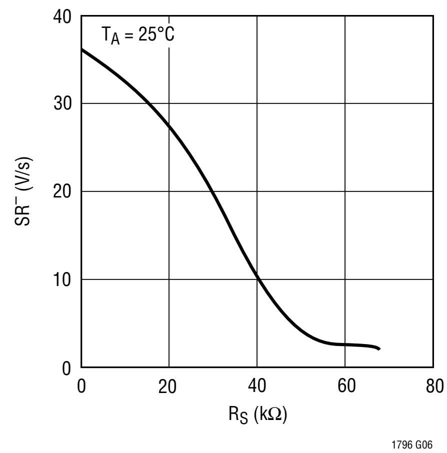
R_S Pin Current vs R_S



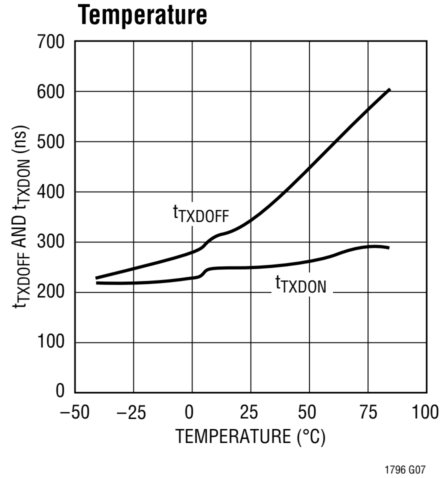
Positive Slew Rate vs R_S



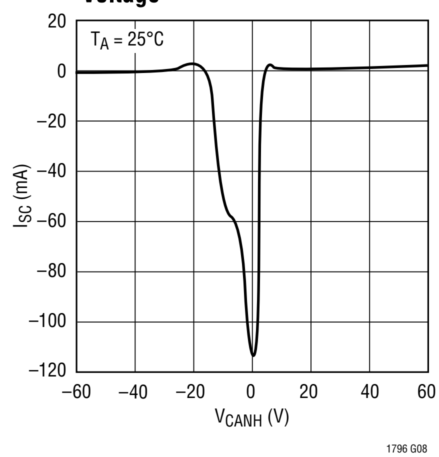
Negative Slew Rate vs R_S



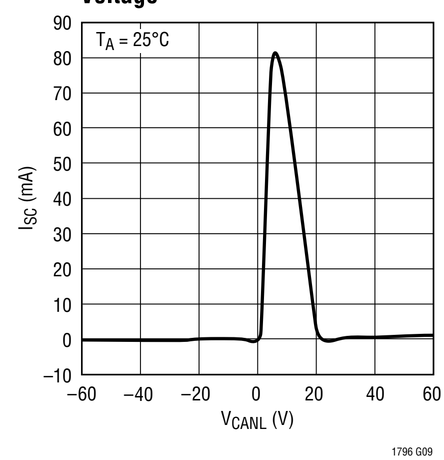
Transmitter Propagation Delay vs Temperature



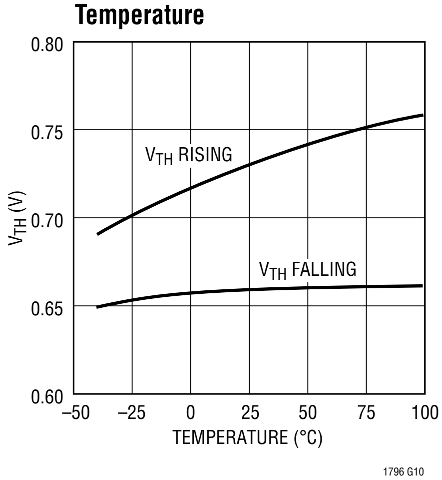
CANH Short-Circuit Current vs Voltage



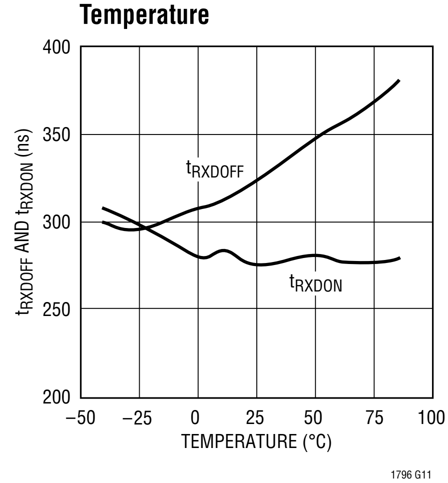
CANL Short-Circuit Current vs Voltage



Receiver Thresholds vs Temperature



Receiver Propagation Delay vs Temperature



PIN FUNCTIONS

TXD (Pin 1): Driver Input. Logic-level thresholds are set by V_{REF}. A logic input level higher than V_{REF} turns the driver outputs off, releasing control of the CANH and CANL lines. A logic input less than V_{REF} turns the driver outputs on, pulling CANH high and CANL low. An open TXD input will float high, turning the driver outputs off. The TXD input pin can withstand voltages from –0.3V to 44V with no damage.

GND (Pin 2): Ground.

V_{CC} (Pin 3): Positive Supply Input. Normal operation is with a 4.75V to 5.25V supply. Operation with supplies up to 44V is possible with unterminated bus lines. Operation at high voltages with normally terminated busses will result in excessive power dissipation and activation of the thermal shutdown circuit. V_{CC} should be decoupled with a 0.1µF low ESR capacitor placed as close to the supply pin as possible.

RXD (Pin 4): Receiver TTL Level-Logic Output. A high level output indicates a recessive state (zero-volt differential) bus. A dominant state forces a low receiver output.

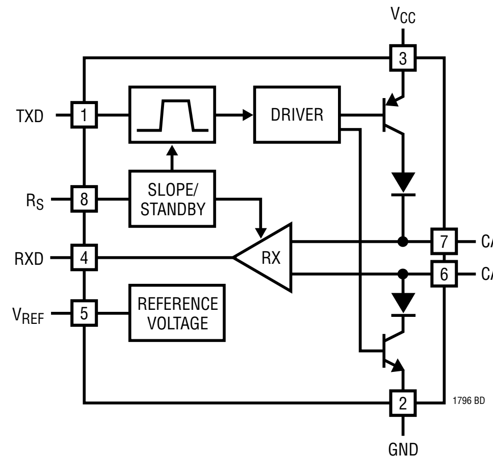
V_{REF} (Pin 5): Reference Output. The reference voltage sets the TXD input threshold and the recessive bus common mode voltage at CANH and CANL. V_{REF} is approximately $V_{CC}/2$ for low voltage operation. When $V_{CC} > 7.5V$, V_{REF} maintains a 3.5V level.

CANL (Pin 6): CAN Bus Low Data Line. The CANL pin is one input to the receiver and the low driver output. In the dominant state (TXD low), the driver pulls the CANL pin to within 1V of GND. In the recessive state (TXD high), the driver output stays high impedance. The CANL pin is protected from voltage faults from –60V to 60V in dominant, recessive, standby or powered off modes. On-chip ESD protection meets IEC-1000-4-2 levels.

CANH (Pin 7): CAN Bus High Data Line. The CANH pin is one input to the receiver and the high driver output. In the dominant state (TXD low), the driver pulls the CANH pin to within 1V of V_{CC}. In the recessive state (TXD high), the driver output stays high impedance. The CANH pin is protected from voltage faults from –60V to 60V in dominant, recessive, standby or powered off modes. On-chip ESD protection meets IEC-1000-4-2 levels.

R_S (Pin 8): Slope Control. This pin is a multifunction control pin. When R_S is high ($V_{RS} > 4V$), the circuit goes into a low power standby mode. In standby, the driver always stays in a high impedance (recessive) state. The receiver operates in a low power (slow) monitoring mode. Received data may be used to "wake-up" the system to full functionality. Full speed normal operation occurs if R_S is tied low through a resistance of less than 3k. The current out of R_S will be limited to about 500µA in the low state. Controlling the current out of R_S with a resistor greater than 3k or by using a current source allows slew rate control of the data output onto CANH and CANL.

BLOCK DIAGRAM



TEST CIRCUIT

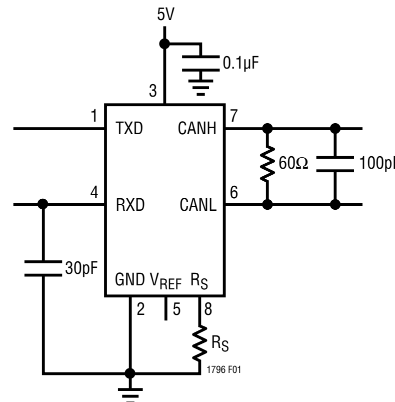


Figure 1. Switching Test Circuit

TIMING DIAGRAM

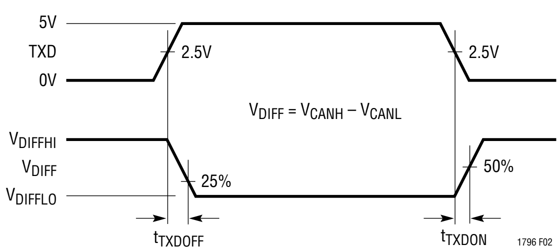


Figure 2. Driver Delay Waveforms

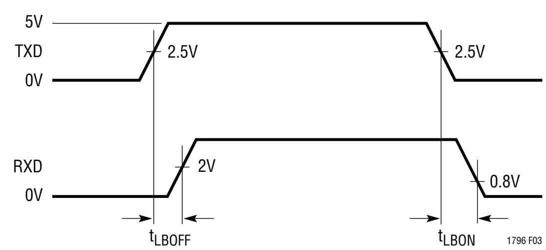


Figure 3. Loopback Delay Waveforms

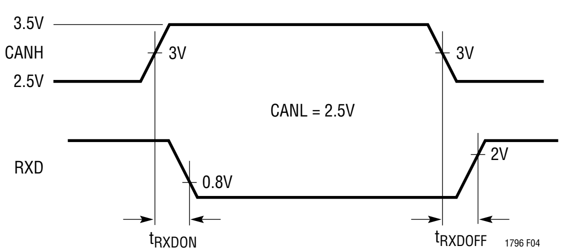


Figure 4. Receiver Delay Waveforms

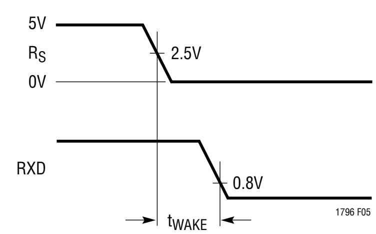


Figure 5. Wake Up from Standby Waveforms

FUNCTION TABLES

Driver Output

INPUTS		BUS TERMINALS		
TXD	R_S	CANH	CANL	OPERATING STATE
0	$V_{RS} < 3V$	High	Low	Dominant
0	$V_{RS} > 4V$	Hi-Z	Hi-Z	Standby
1	$V_{RS} < 3V$	Hi-Z	Hi-Z	Recessive
1	$V_{RS} > 4V$	Hi-Z	Hi-Z	Standby

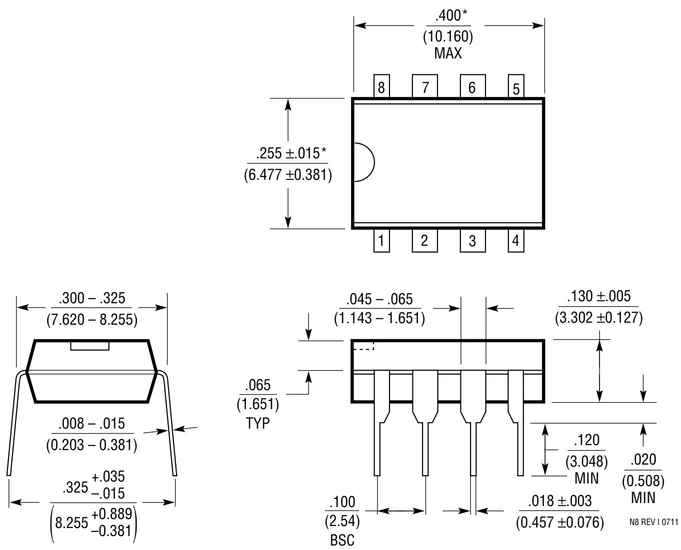
Receiver Output

BUS VOLTAGE $V_{BUS} = V_{CANH} - V_{CANL}$	R_S	RXD	RESPONSE TIME
$V_{BUS} < 0.5V$	<3V	High	Fast
$0.5V \le V_{BUS} \le 0.9V$	<3V	Indeterminate	Fast
$V_{BUS} > 0.9V$	<3V	Low	Fast
$V_{BUS} < 0.5V$	>4V	High	Slow
$0.5V \le V_{BUS} \le 0.9V$	>4V	Indeterminate	Slow
$V_{BUS} > 0.9V$	>4V	Low	Slow

PACKAGE DESCRIPTION

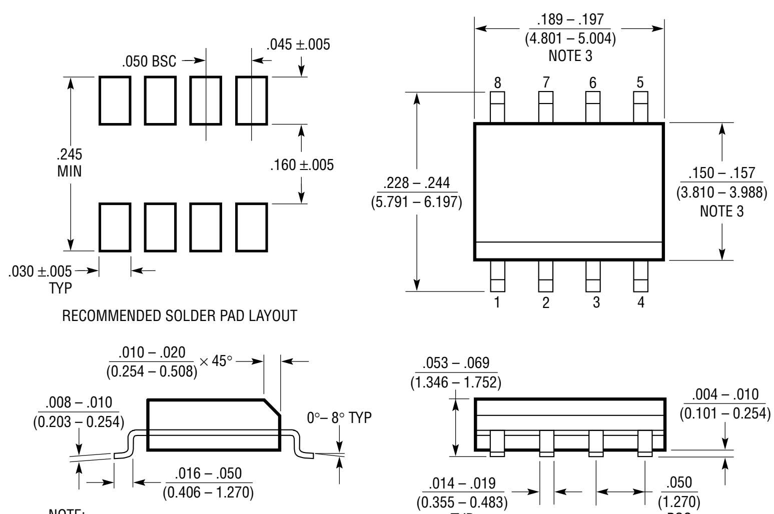
Please refer to http://www.linear.com/designtools/packaging/ for the most recent package drawings.

N Package
8-Lead PDIP (Narrow .300 Inch)
(Reference LTC DWG # 05-08-1510 Rev I)



NOTE:
1. DIMENSIONS ARE INCHES / MILLIMETERS
*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCH (0.254mm)

S8 Package
8-Lead Plastic Small Outline (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1610 Rev G)



NOTE:
1. DIMENSIONS IN INCHES / (MILLIMETERS)
2. DRAWING NOT TO SCALE
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)
4. PIN 1 CAN BE BEVEL EDGE OR A DIMPLE

SO8 REV G 0212

REVISION HISTORY

REV	DATE	DESCRIPTION	PAGE NUMBER
A	8/15	Increased t_{TXDOFF} max limit	4