

# DS36950 Quad Differential Bus Transceiver

## General Description

The DS36950 is a low power, space-saving quad EIA-485 differential bus transceiver especially suited for high speed, parallel, multipoint, computer I/O bus applications. A compact 20-pin surface mount PLCC package provides high transceiver integration and a very small PC board footprint.

Timing uncertainty across an interface using multiple devices, a typical problem in a parallel interface, is specified—minimum and maximum propagation delay times are guaranteed.

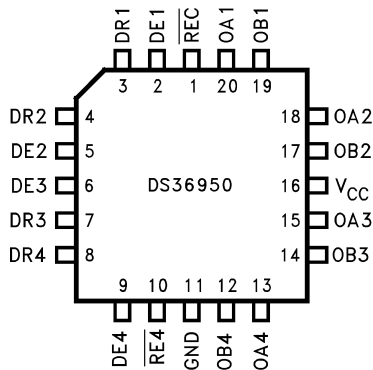
Six devices can implement a complete IPI master or slave interface. Three transceivers in a package are pinned out for

connection to a parallel databus. The fourth transceiver, with the flexibility provided by its individual enables, can serve as a control bus transceiver.

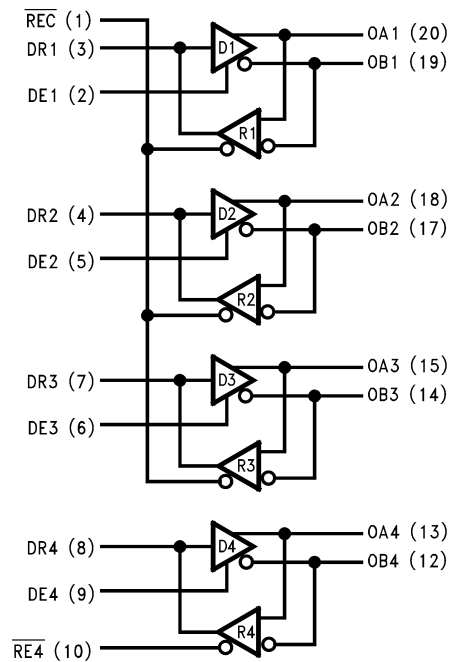
## Features

- Pinout for IPI interface
- Compact 20-pin PLCC package
- Meets EIA-485 standard for multipoint bus transmission
- Greater than 60 mA source/sink
- Thermal Shutdown Protection

## Pinout and Logic Diagram



Order Number DS36950  
See NS Package Number V20A



**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	7V
Control Input Voltage	$V_{CC} + 0.5V$
Driver Input Voltage	$V_{CC} + 0.5V$
Driver Output Voltage/Receiver Input Voltage	-10V to +15V
Receiver Output Voltage	5.5V
Continuous Power Dissipation @ 25°C	
V Package	1.73W

Derate V Package 13.9 mW/°C above 25°C

Storage Temp. Range	-65°C to +150°C
Lead Temp. (Soldering 4 Sec.)	260°C

**Recommended Operating Conditions**

Supply Voltage, $V_{CC}$	4.75V to 5.25V
Bus Voltage	-7V to +12V
Operating Free Air Temp. ( $T_A$ )	0°C to +70°C

**Electrical Characteristics** (Note 2)

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>DRIVER CHARACTERISTICS</b>						
$V_{ODL}$	Differential Driver Output Voltage (Full Load)	$I_L = 60\text{ mA}$ $V_{CM} = 0V$	1.5	1.9		V
$V_{OD}$	Differential Driver Output Voltage (Termination Load)	$R_L = 100\Omega$ (EIA-422)	2.0	3.5		V
		$R_L = 54\Omega$ (EIA-485)	1.5	3.2		V
$\Delta V_{ODI}$	Change in Magnitude of Driver Differential Output Voltage for Complementary Output States	$R_L = 54\Omega$ or $100\Omega$ (Note 4) (Figure 1) (EIA-485)			0.2	V
$V_{OC}$	Driver Common Mode Output Voltage (Note 5)	$R_L = 54\Omega$ (Figure 1) (EIA-485)			3.0	V
$\Delta V_{OCI}$	Change in Magnitude of Common Mode Output Voltage	(Note 4) (Figure 1) (EIA-485)			0.2	V
$V_{OH}$	Output Voltage HIGH	$I_{OH} = -55\text{ mA}$	2.7	3.2		V
$V_{OL}$	Output Voltage LOW	$I_{OL} = 55\text{ mA}$		1.4	1.7	V
$V_{IH}$	Input Voltage HIGH		2.0			V
$V_{IL}$	Input Voltage LOW				0.8	V
$V_{CL}$	Input Clamp Voltage	$I = -18\text{ mA}$			-1.5	V
$I_{IH}$	Input High Current	$V_I = 2.4V$ (Note 3)			20	$\mu\text{A}$
$I_{IL}$	Input Low Current	$V_I = 0.4V$ (Note 3)			-20	$\mu\text{A}$
$I_{OSC}$	Driver Short-Circuit Output Current (Note 9)	$V_O = -7V$ (EIA-485)		-130	-250	mA
		$V_O = 0V$ (EIA-422)		-90	-150	mA
		$V_O = +12V$ (EIA-485)		130	250	mA
<b>RECEIVER CHARACTERISTICS</b>						
$I_{OSR}$	Short Circuit Output Current	$V_O = 0V$ (Note 9)	-15	-28	-75	mA
$I_{OZ}$	TRI-STATE® Output Current	$V_O = 0.4V$ to $2.4V$			20	$\mu\text{A}$
$V_{OH}$	Output Voltage High	$V_{ID} = 0.20V$ , $I_{OH} = -0.4\text{ mA}$	2.4	3.0		V
$V_{OL}$	Output Voltage Low	$V_{ID} = -0.20V$ , $I_{OL} = 4\text{ mA}$		0.35	0.5	V
$V_{TH}$	Differential Input High Threshold Voltage	$V_O = V_{OH}$ , $I_O = -0.4\text{ mA}$ (EIA-422/485)		0.03	0.20	V
$V_{TL}$	Differential Input Low Threshold Voltage (Note 6)	$V_O = V_{OL}$ , $I_O = 4.0\text{ mA}$ (EIA-422/485)	-0.20	-0.03		V
$V_{HST}$	Hysteresis (Note 7)	$V_{CM} = 0V$	35	60		mV
<b>DRIVER AND RECEIVER CHARACTERISTICS</b>						
$V_{IH}$	Enable Input Voltage High		2.0			V
$V_{IL}$	Enable Input Voltage Low				0.8	V

## Electrical Characteristics (Note 2) (Continued)

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
<b>DRIVER AND RECEIVER CHARACTERISTICS</b>							
$V_{CL}$	Enable Input Clamp Voltage	$I = -18 \text{ mA}$			-1.5	V	
$I_{IN}$	Line Input Current (Note 8)	Other Input = 0V	$V_I = +12\text{V}$		0.5	1	mA
			$V_I = -7\text{V}$		-0.45	-0.8	mA
$I_{IH}$	Enable Input Current High	$V_{OH} = 2.4\text{V}$	$\overline{RE4}$ or DE			20	$\mu\text{A}$
			$\overline{REC}$			60	$\mu\text{A}$
$I_{IL}$	Enable Input Current Low	$V_{OL} = 0.4\text{V}$	$\overline{RE4}$ or DE			-20	$\mu\text{A}$
			$\overline{REC}$			-60	$\mu\text{A}$
$I_{CC}$	Supply Current (Note 10)	No Load, Outputs Enabled		75	90	mA	
$I_{CCZ}$	Supply Current (Note 10)	No Load, Outputs Disabled		50	70	mA	

## Switching Characteristics

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified

Symbol	Conditions	Min	Typ	Max	Units	
<b>DRIVER SINGLE-ENDED CHARACTERISTICS</b>						
$t_{PZH}$	$R_L = 110\Omega$ (Figure 4)		35	40	ns	
$t_{PZL}$	$R_L = 110\Omega$ (Figure 5)		25	40	ns	
$t_{PHZ}$	$R_L = 110\Omega$ (Figure 4)		15	25	ns	
$t_{PLZ}$	$R_L = 110\Omega$ (Figure 5)		35	40	ns	
<b>DRIVER DIFFERENTIAL CHARACTERISTICS</b>						
$t_R, t_F$	Rise & Fall Time	$R_L = 54\Omega$		13	16	ns
$t_{PLHD}$	Differential Propagation	$C_L = 50 \text{ pF}$	9	15	19	ns
$t_{PHLD}$	Delays (Note 15)	$C_D = 15 \text{ pF}$	9	15	19	ns
$t_{SKD}$	$ t_{PLHD} - t_{PHLD} $ Differential Skew	(Figures 3, 8)		3	6	ns
<b>RECEIVER CHARACTERISTICS</b>						
$t_{PLHD}$	Differential Propagation Delays		9	14	19	ns
$t_{PHLD}$	$C_L = 15 \text{ pF}, V_{CM} = 1.5\text{V}$ (Figure 6)		9	14	19	ns
$t_{SKD}$	$ t_{PLHD} - t_{PHLD} $ Differential Receiver Skew			1	3	ns
$t_{ZH}$	Output Enable Time to High Level	$C_L = 15 \text{ pF}$ (Figure 7)		15	22	ns
$t_{ZL}$	Output Enable Time to Low Level			20	30	ns
$t_{HZ}$	Output Disable Time from High Level			10	17	ns
$t_{LZ}$	Output Disable Time from Low Level			17	25	ns

**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 define as positive. Current out of device pins is defined as negative. All voltages are referenced to ground unless otherwise specified.

**Note 3:**  $I_{IH}$  and  $I_{IL}$  includes driver input current and receiver TRI-STATE leakage current.

**Note 4:**  $\Delta V_{OD}$  and  $\Delta V_{OC}$  are changes in magnitude of  $V_{OD}$  and  $V_{OC}$ , respectively, that occur when the input changes state.

**Note 5:** In EIA Standards EIA-422 and EIA-485,  $V_{OC}$ , which is the average of the two output voltages with respect to ground, is called output offset voltage,  $V_{OS}$ .

**Note 6:** Threshold parameter limits specified as an algebraic value rather than by magnitude.

**Note 7:** Hysteresis defined as  $V_{HST} = V_{TH} - V_{TL}$ .

**Note 8:**  $I_{IN}$  includes the receiver input current and driver TRI-STATE leakage current.

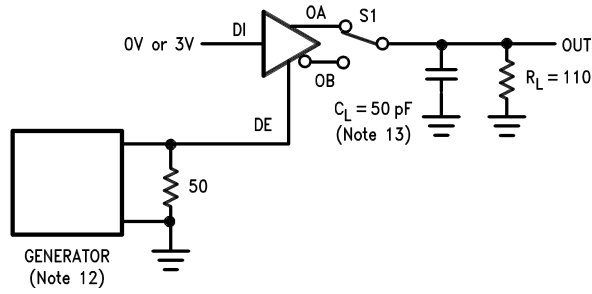
**Note 9:** Short one output at a time.

**Note 10:** Total package supply current.

**Note 11:** All typicals are given for  $V_{CC} = 5.0\text{V}$  and  $T_A = 25^\circ\text{C}$ .

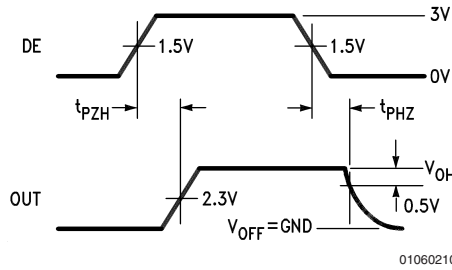


Parameter Measurement Information (Continued)



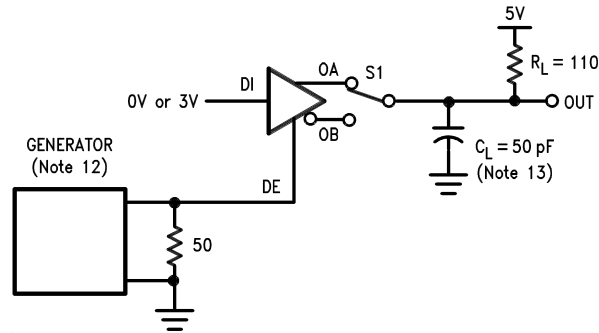
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S1 to OA for DI = 3V  
S1 to OB for DI = 0V



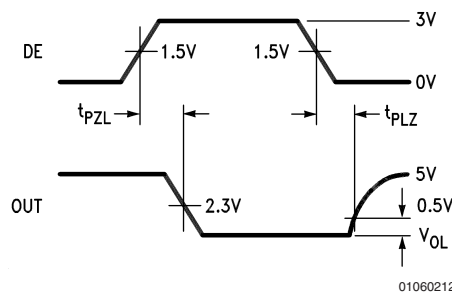
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FIGURE 4. Driver Enable and Disable Timing ( $t_{PZH}$ ,  $t_{PHZ}$ )



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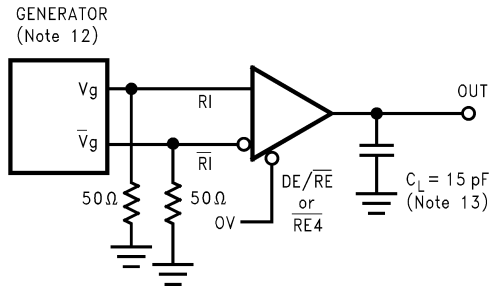
S1 to OA for DI = 0V  
S1 to OB for DI = 3V



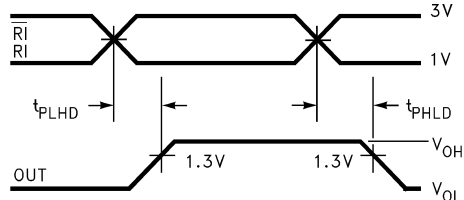
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FIGURE 5. Driver Enable and Disable Timing ( $t_{PZL}$ ,  $t_{PLZ}$ )

Parameter Measurement Information (Continued)



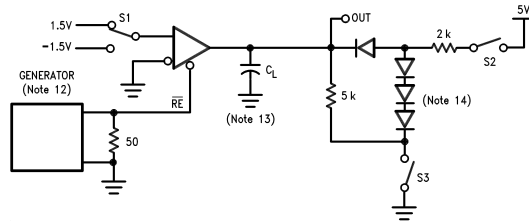
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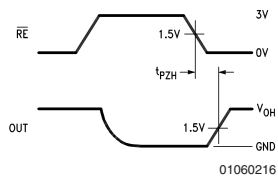
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FIGURE 6. Receiver Differential Propagation Delay Timing

Parameter Measurement Information (Continued)

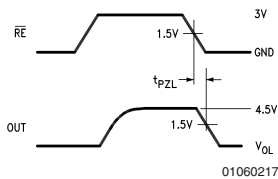


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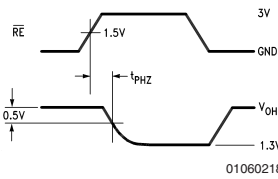
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S1 1.5V  
S2 OPEN  
S3 CLOSED



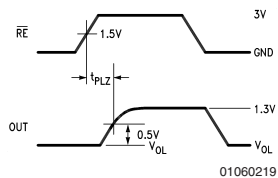
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S1 -1.5V  
S2 CLOSED  
S3 OPEN



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S1 1.5V  
S2 CLOSED  
S3 CLOSED

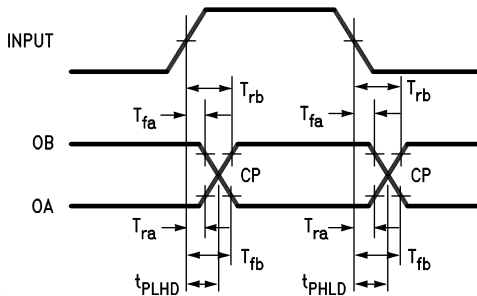


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S1 -1.5V  
S2 CLOSED  
S3 CLOSED

FIGURE 7. Receiver Enable and Disable Timing

## Parameter Measurement Information (Continued)



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TCP = Crossing Point

Tra, Trb, Tfa, and Tfb are propagation delay measurements to the 20% and 80% levels.

$$TCP = \frac{(Tfb \times Trb) - (Tra \times Tfa)}{Trb - Tra - Tfa + Tfb}$$

**FIGURE 8. Propagation Delay Timing for Calculation of Driver Differential Propagation Delays**

**Note 12:** The input pulse is supplied by a generator having the following characteristics:

f = 1.0 MHz, 50% Duty Cycle,  $t_r$  and  $t_f < 6.0$  ns,  $Z_0 = 50\Omega$

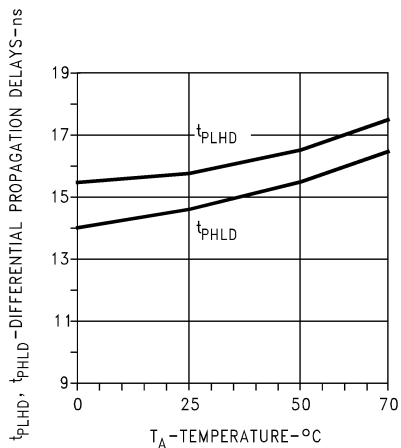
**Note 13:**  $C_L$  includes probe and stray capacitance.

**Note 14:** Diodes are 1N916 or equivalent.

**Note 15:** Differential propagation delays are calculated from single-ended propagation delays measured from driver input to the 20% and 80% levels on the driver outputs (See Figure 8).

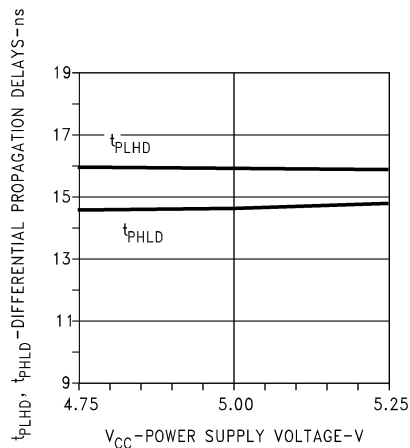
## Typical Performance Characteristics

**Driver Differential Propagation Delay vs Temperature**



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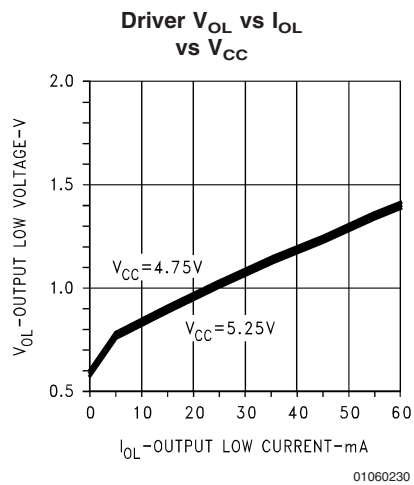
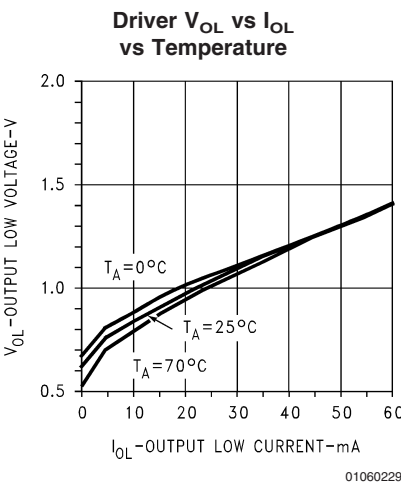
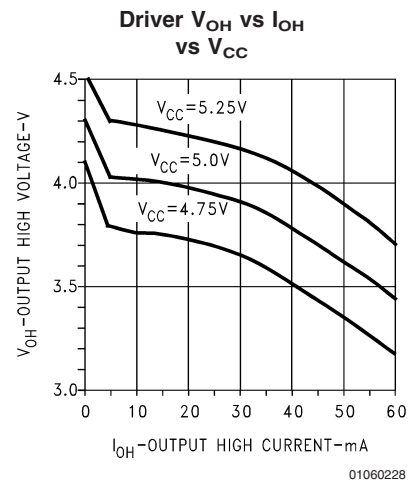
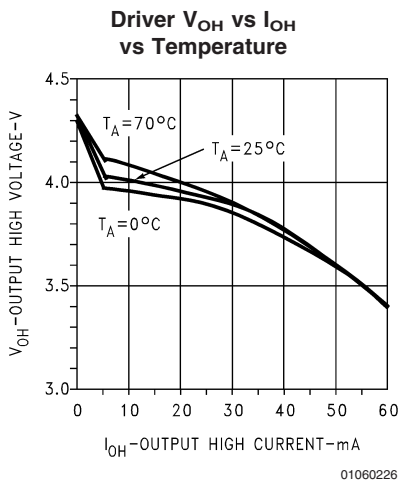
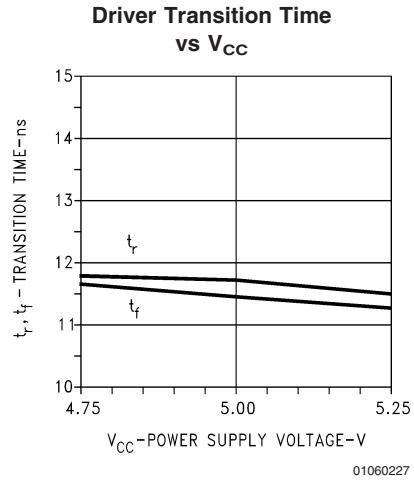
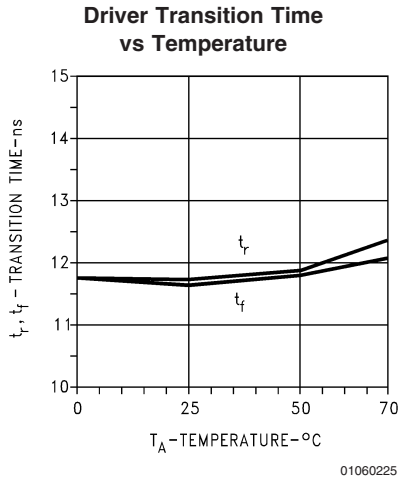
**Driver Differential Propagation Delay vs VCC**



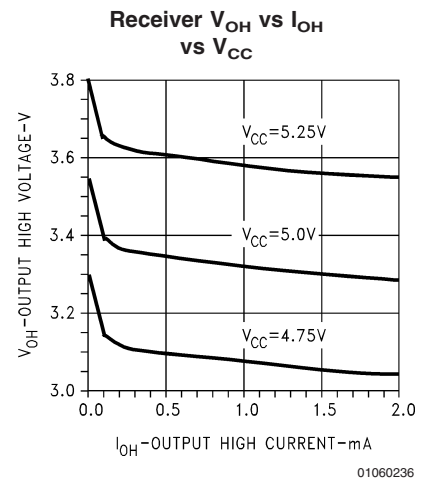
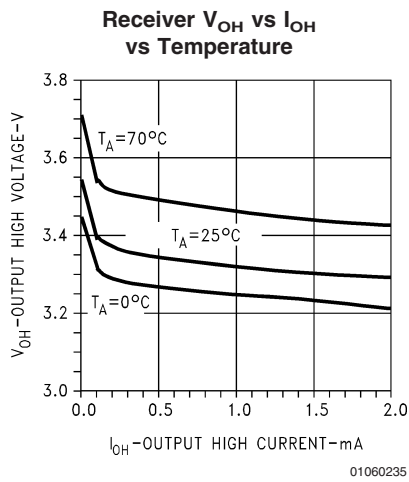
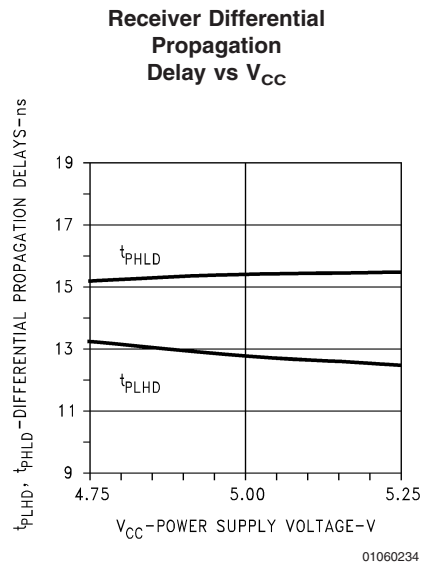
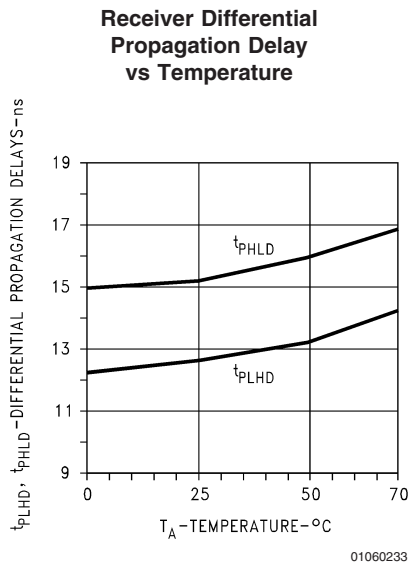
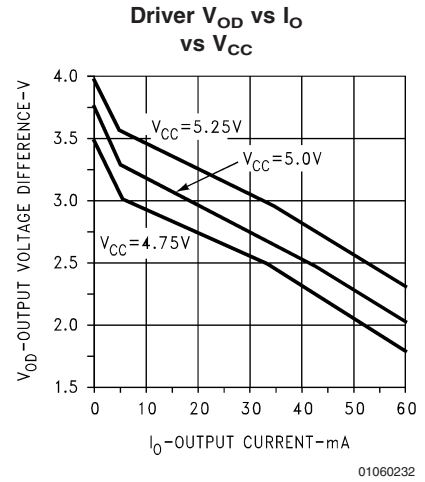
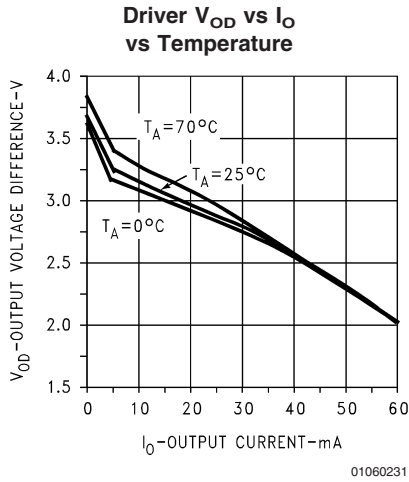
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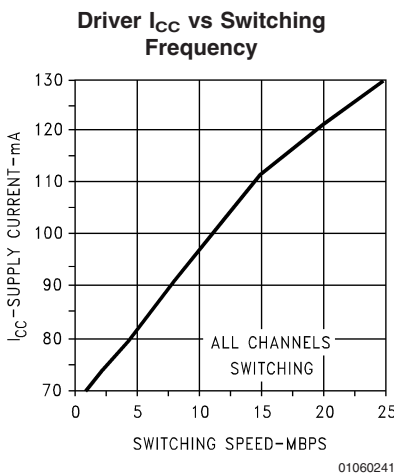
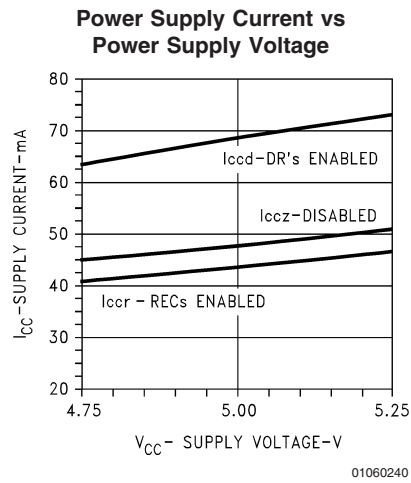
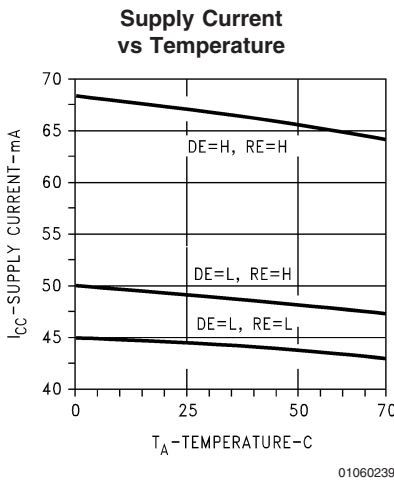
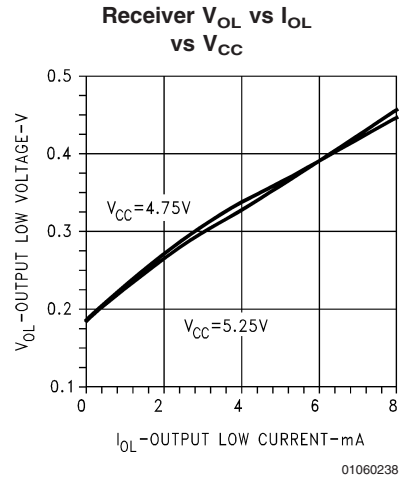
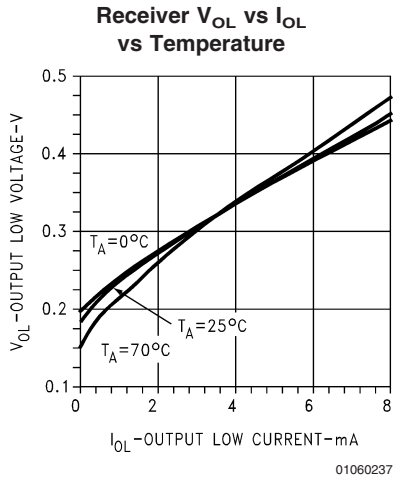
Typical Performance Characteristics (Continued)



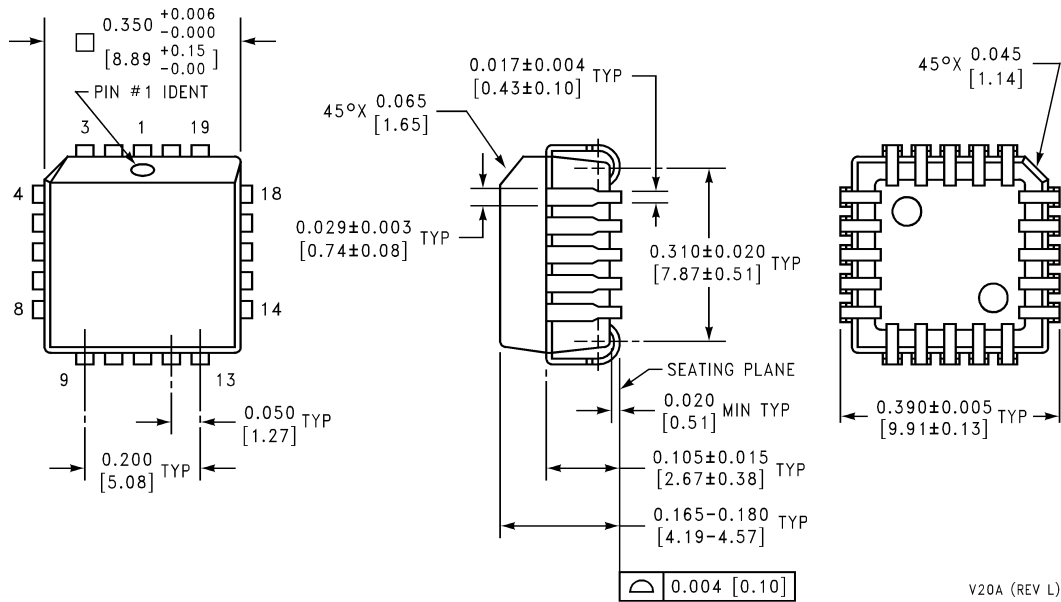
Typical Performance Characteristics (Continued)



Typical Performance Characteristics (Continued)



**Physical Dimensions** inches (millimeters) unless otherwise noted



Order Number DS36950  
NS Package Number V20A

V20A (REV L)

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