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National Semiconductor

July 1998

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.

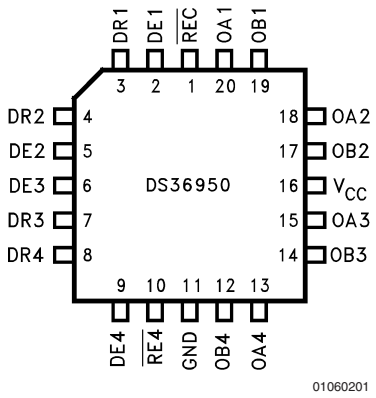
Timing uncertainty across an interface using multiple devices, a typical problem in a parallel interface, is specified — minimum and maximum propagation delay times are guaranteed.

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



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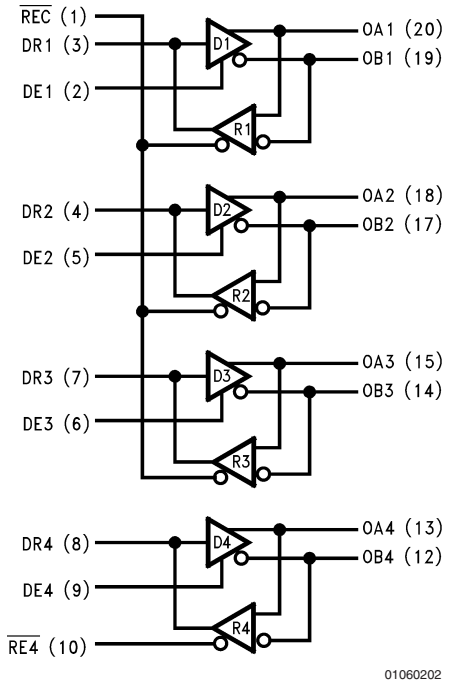
Order Number DS36950
See NS Package Number V20A



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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
DRIVER CHARACTERISTICS						
V_{ODL}	Differential Driver Output Voltage (Full Load)	I_L = 60 mA, V_{CM} = 0V	1.5	1.9		V
V_{OD}	Differential Driver Output Voltage (Termination Load)	R_L = 100Ω (EIA-422)	2.0	3.5		V
		R_L = 54Ω (EIA-485)	1.5	3.2		V
$\Delta\lvert V_{OD}\rvert$	Change in Magnitude of Driver Differential Output Voltage for Complementary Output States	R_L = 54Ω or 100Ω (Note 4) (*Figure 1*) (EIA-485)			0.2	V
V_{OC}	Driver Common Mode Output Voltage (Note 5)	R_L = 54Ω (*Figure 1*) (EIA-485)			3.0	V
$\Delta\lvert V_{OC}\rvert$	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 mA	2.7	3.2		V
V_{OL}	Output Voltage LOW	I_{OL} = 55 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 mA			−1.5	V
I_{IH}	Input High Current	V_I = 2.4V (Note 3)			20	µA
I_{IL}	Input Low Current	V_I = 0.4V (Note 3)			−20	µA
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
RECEIVER CHARACTERISTICS						
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	µA
V_{OH}	Output Voltage High	V_{ID} = 0.20V, I_{OH} = −0.4 mA	2.4	3.0		V
V_{OL}	Output Voltage Low	V_{ID} = −0.20V, I_{OL} = 4 mA		0.35	0.5	V
V_{TH}	Differential Input High Threshold Voltage	V_O = V_{OH}, I_O = −0.4 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 mA (EIA-422/485)	−0.20	−0.03		V
V_{HST}	Hysteresis (Note 7)	V_{CM} = 0V	35	60		mV
DRIVER AND RECEIVER CHARACTERISTICS						
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
DRIVER AND RECEIVER CHARACTERISTICS							
V_{CL}	Enable Input Clamp Voltage	I = −18 mA				−1.5	V
I_{IN}	Line Input Current	Other Input = 0V	V_I = +12V		0.5	1	mA
	(Note 8)		V_I = −7V		−0.45	−0.8	mA
I_{IH}	Enable Input Current High	V_{OH} = 2.4V	$\overline{RE4}$ or DE			20	µA
			$\overline{REC}$			60	µA
I_{IL}	Enable Input Current Low	V_{OL} = 0.4V	$\overline{RE4}$ or DE			−20	µA
			$\overline{REC}$			−60	µA
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
DRIVER SINGLE-ENDED CHARACTERISTICS						
t_{PZH}	R_L = 110Ω (*Figure 4*)			35	40	ns
t_{PZL}	R_L = 110Ω (*Figure 5*)			25	40	ns
t_{PHZ}	R_L = 110Ω (*Figure 4*)			15	25	ns
t_{PLZ}	R_L = 110Ω (*Figure 5*)			35	40	ns
DRIVER DIFFERENTIAL CHARACTERISTICS						
t_R, t_F	Rise & Fall Time	R_L = 54Ω		13	16	ns
t_{PLHD}	Differential Propagation	C_L = 50 pF	9	15	19	ns
t_{PHLD}	Delays (Note 15)	C_D = 15 pF	9	15	19	ns
t_{SKD}	$\lvert t_{PLHD} - t_{PHLD} \rvert$ Differential Skew	(*Figures 3, 8*)		3	6	ns
RECEIVER CHARACTERISTICS						
t_{PLHD}	Differential Propagation Delays		9	14	19	ns
t_{PHLD}	C_L = 15 pF, V_{CM} = 1.5V (*Figure 6*)		9	14	19	ns
t_{SKD}	$\lvert t_{PLHD} - t_{PHLD} \rvert$ Differential Receiver Skew			1	3	ns
t_{ZH}	Output Enable Time to High Level			15	22	ns
t_{ZL}	Output Enable Time to Low Level	C_L = 15 pF		20	30	ns
t_{HZ}	Output Disable Time from High Level	(*Figure 7*)		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} = 5.0V and T_A = 25˚C.

Parameter Measurement Information

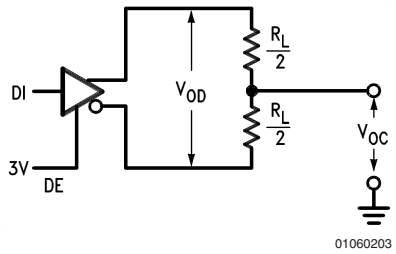


FIGURE 1. Driver V_{OD} and V_{OC}

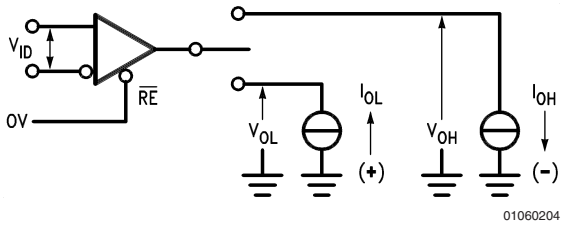


FIGURE 2. Receiver V_{OH} and V_{OL}

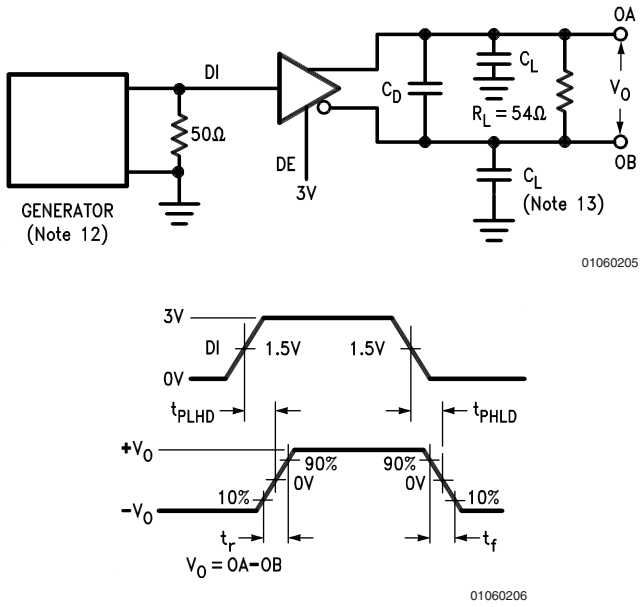
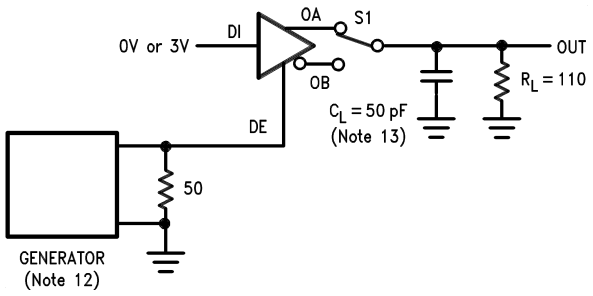


FIGURE 3. Driver Differential Propagation Delay and Transition Timing

Parameter Measurement Information (Continued)



S1 to OA for DI = 3V

S1 to OB for DI = 0V

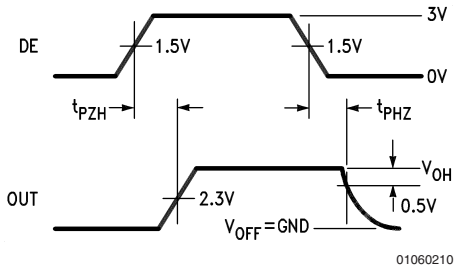
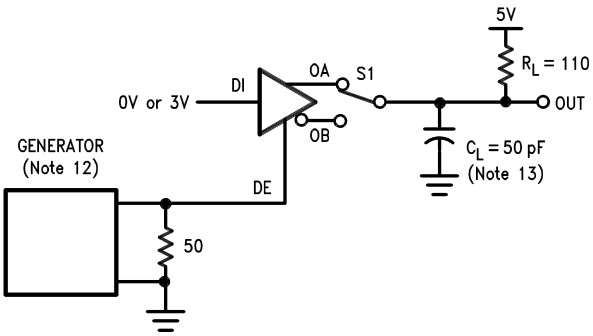


FIGURE 4. Driver Enable and Disable Timing (t_{PZH}, t_{PHZ})



S1 to OA for DI = 0V

S1 to OB for DI = 3V

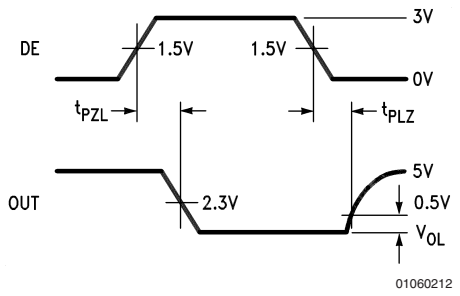


FIGURE 5. Driver Enable and Disable Timing (t_{PZL}, t_{PLZ})

Parameter Measurement Information (Continued)

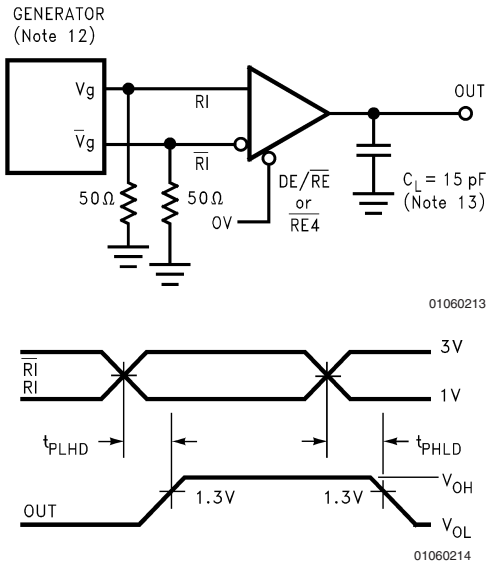
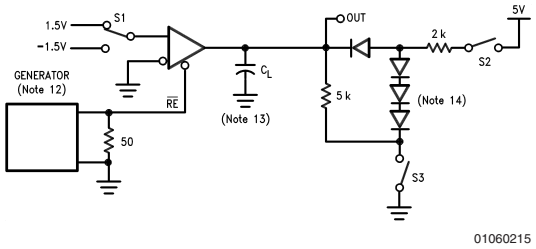


FIGURE 6. Receiver Differential Propagation Delay Timing

Parameter Measurement Information (Continued)



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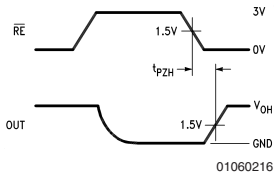

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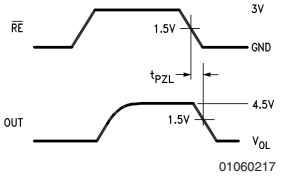
S1 1.5V
S2 OPEN
S3 CLOSED



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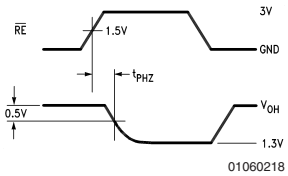
S1 −1.5V
S2 CLOSED
S3 OPEN



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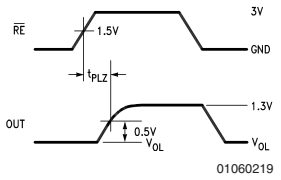
S1 1.5V
S2 CLOSED
S3 CLOSED



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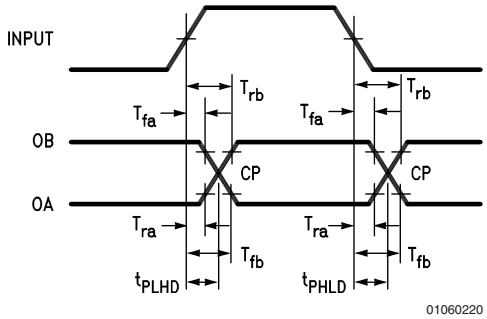
S1 −1.5V
S2 CLOSED
S3 CLOSED

FIGURE 7. Receiver Enable and Disable Timing

Parameter Measurement Information (Continued)



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_f and t_r < 6.0 ns, Z_O = 50Ω

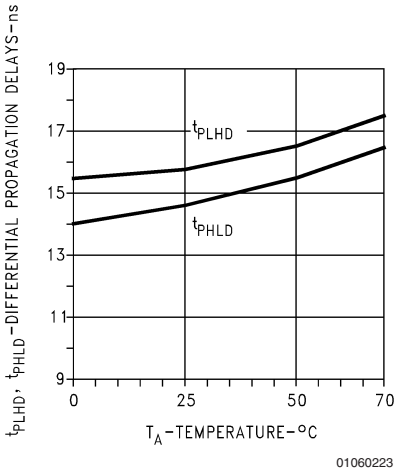
Note 13: C_L includes probe and stray capacitance.

Note 14: Diodes are 1N916 or equivalent.

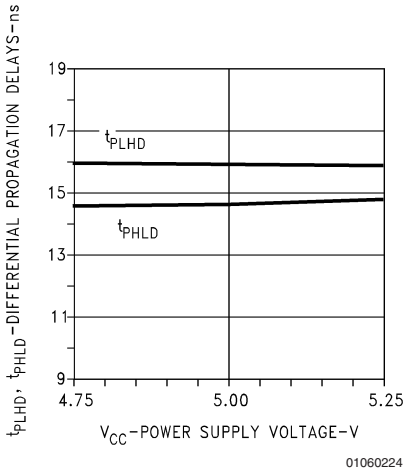
Note 15: Differential propagation delays are calculated from single-ended propagation delays measured from driver input to the 20% and 80% levels on the driver outputs (See *Figure 8*).

Typical Performance Characteristics

Driver Differential Propagation Delay vs Temperature

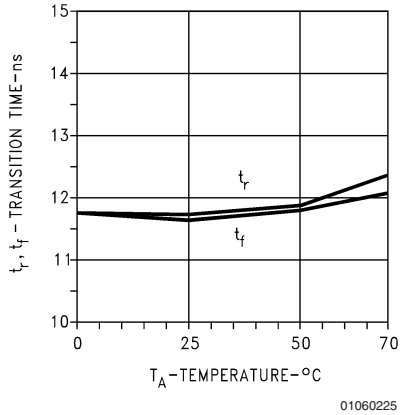


Driver Differential Propagation Delay vs V_{CC}



Typical Performance Characteristics (Continued)

Driver Transition Time vs Temperature



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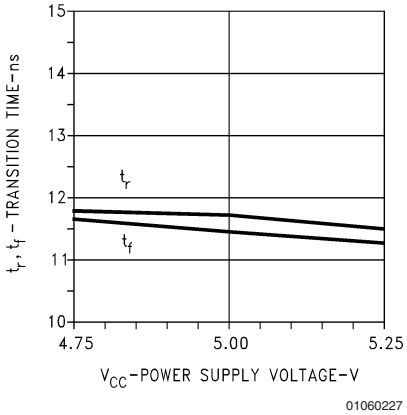
Driver Transition Time vs V_{CC}



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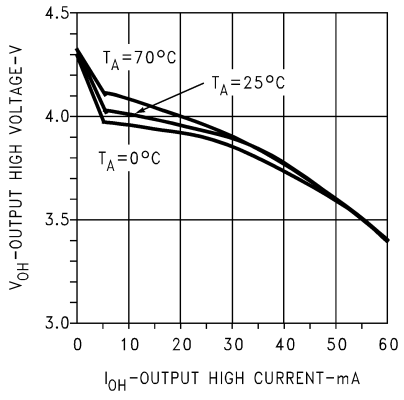
Driver V_{OH} vs I_{OH} vs Temperature



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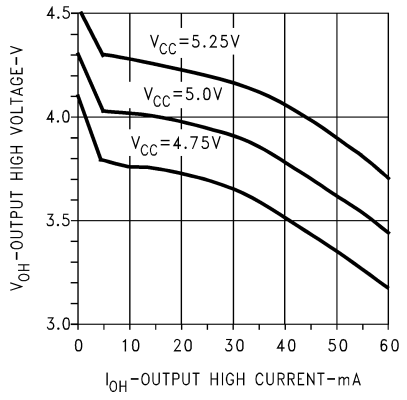
Driver V_{OH} vs I_{OH} vs V_{CC}



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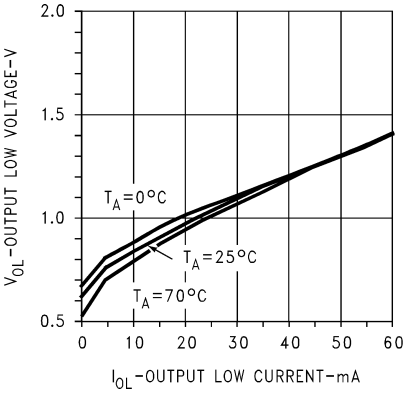
Driver V_{OL} vs I_{OL} vs Temperature



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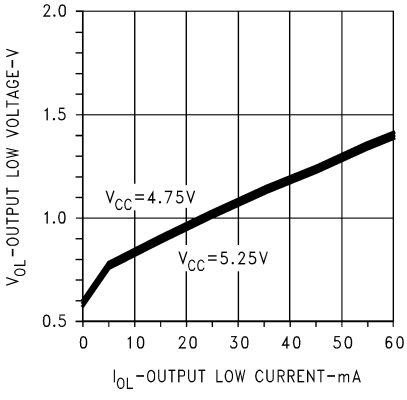
Driver V_{OL} vs I_{OL} vs V_{CC}



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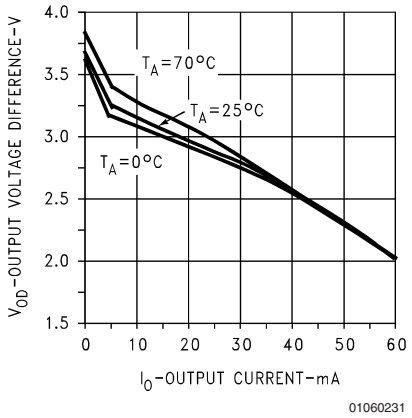
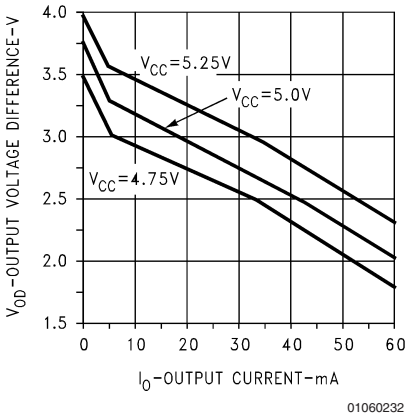
Typical Performance Characteristics (Continued)

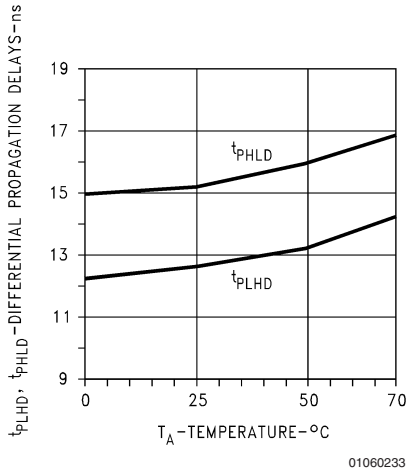
Driver V_{OD} vs I_O vs Temperature



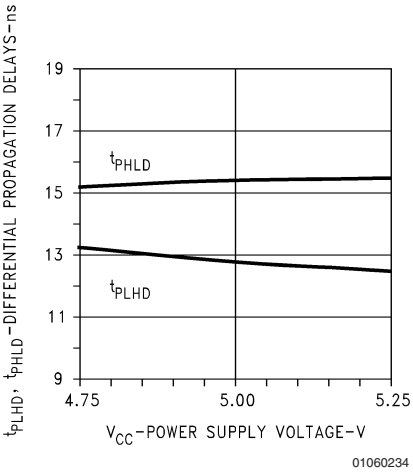
Driver V_{OD} vs I_O vs V_{CC}



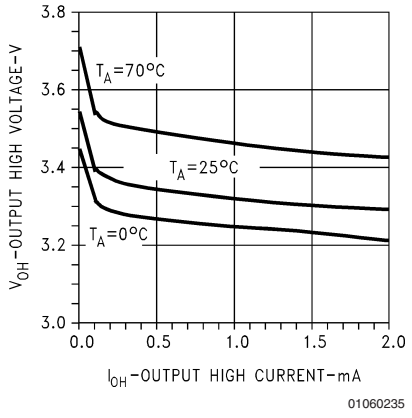
Receiver Differential Propagation Delay vs Temperature



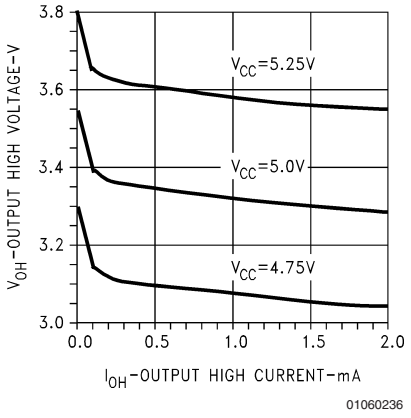
Receiver Differential Propagation Delay vs V_{CC}



Receiver V_{OH} vs I_{OH} vs Temperature

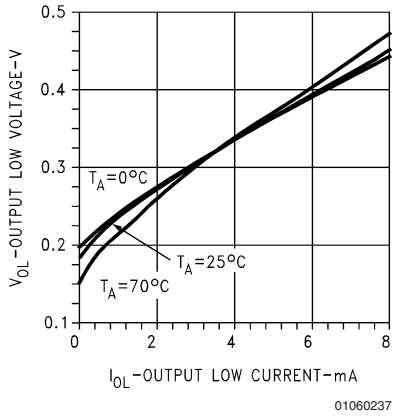


Receiver V_{OH} vs I_{OH} vs V_{CC}

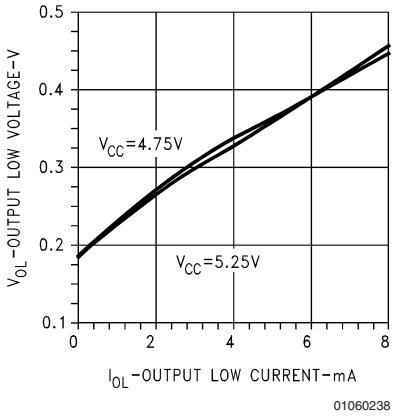


Typical Performance Characteristics (Continued)

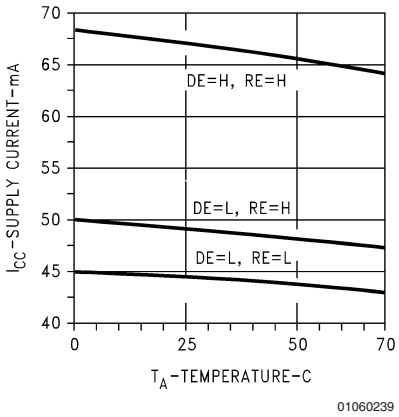
Receiver V_{OL} vs I_{OL} vs Temperature



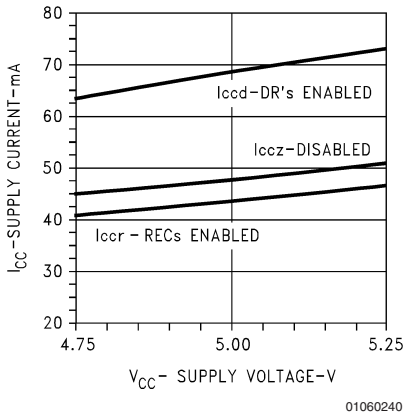
Receiver V_{OL} vs I_{OL} vs V_{CC}



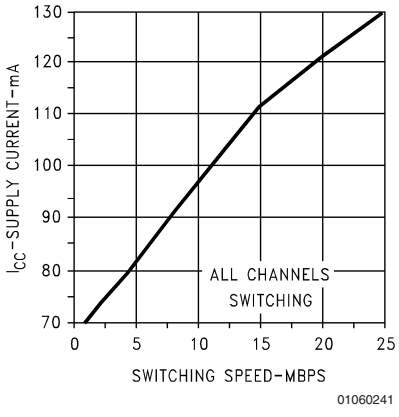
Supply Current vs Temperature



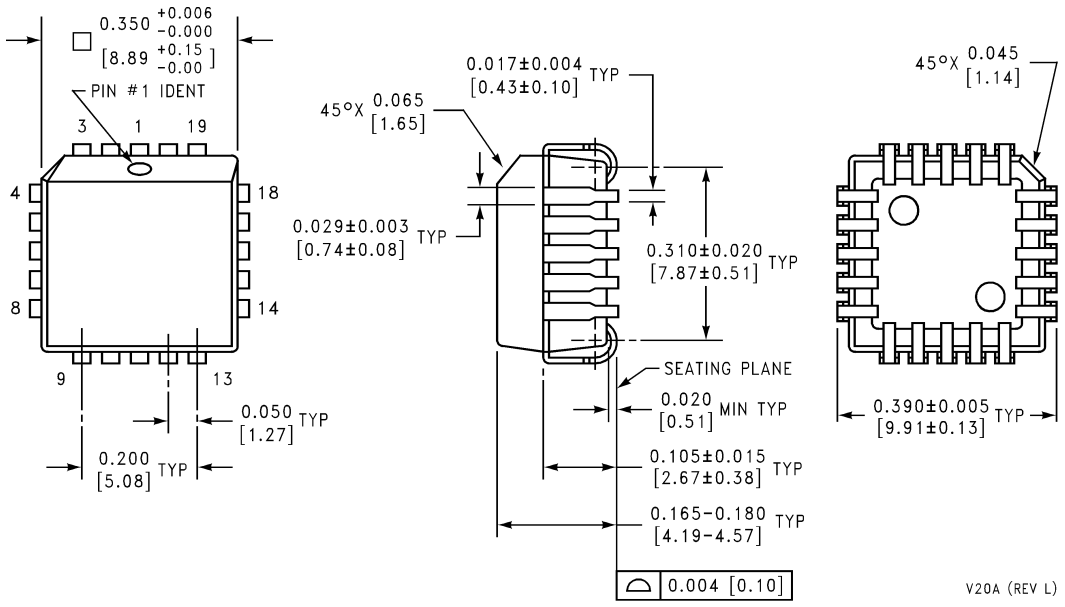
Power Supply Current vs Power Supply Voltage



Driver I_{CC} vs Switching Frequency



Physical Dimensions inches (millimeters) unless otherwise noted



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