Bidirectional 3.3 V Universal LVD Transceiver (G10™)

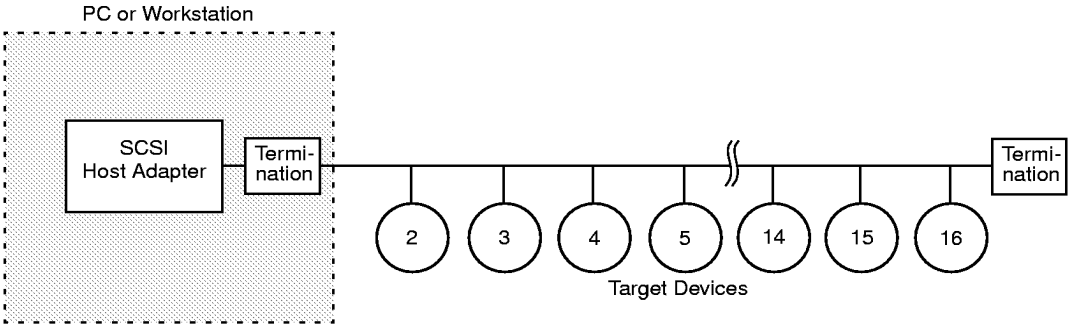
Datasheet

LSI Logic's bidirectional transceiver for SCSI is used to transmit and receive data on a SCSI-2, SCSI-3 10 MHz, SCSI-3 ULTRA, or SCSI-3 ULTRA-2 single-ended or differential bus. The bus operates at rates up to 40 MHz, with a cable length up to 25 m and maximum stub lengths of 0.1 m. SCSI bus termination is assumed to be external to the SCSI device.

This transceiver can operate with SCSI-2, SCSI-3 10-MHz interfaces, SCSI-3 Fast-20, or SCSI-3 Fast-40 interfaces. Typically, the single-ended or differential operating mode is controlled by a "DIFFSENSE" receiver, a description of which is included in this datasheet. This transceiver is implemented in G10 technology.

This transceiver conforms to the *Information Technology - SCSI-3 Parallel Interface Specification SPI-2 Project 1142D*.

Figure 1 SCSI Bus Interface



Features and Benefits

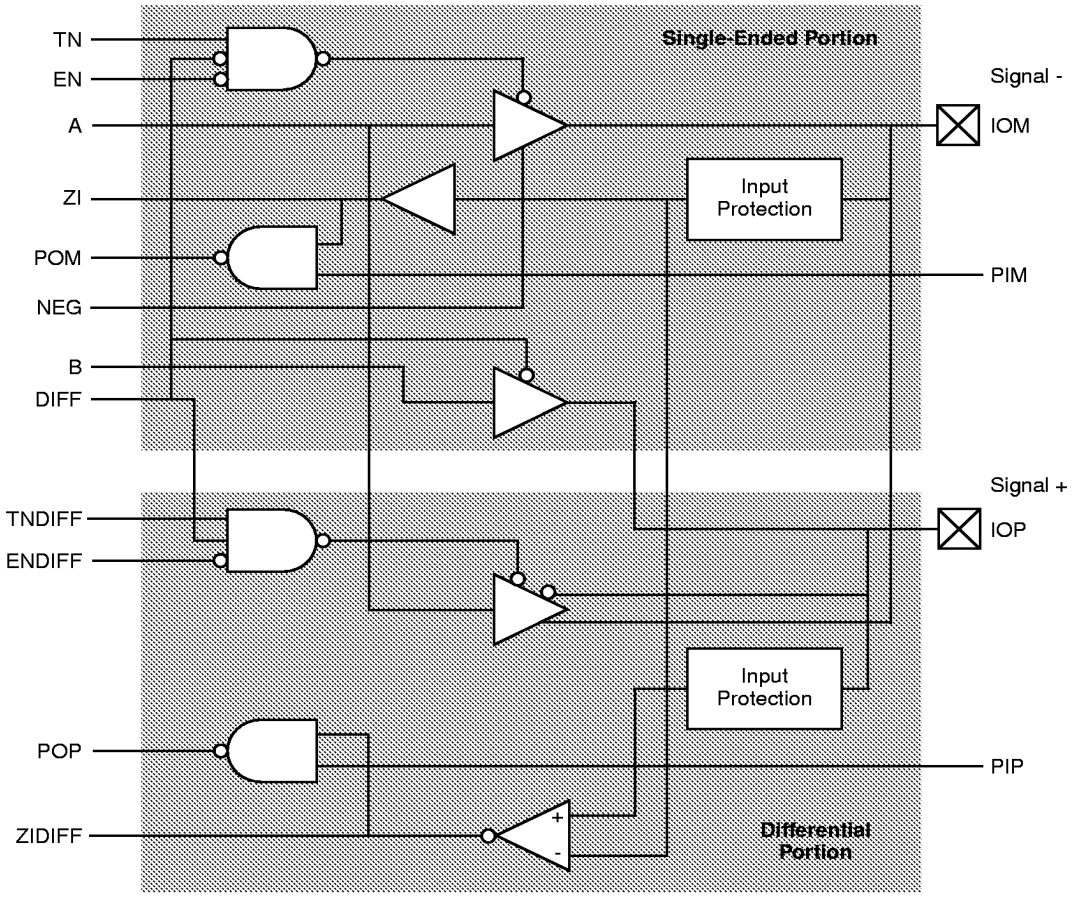
- Complies with *SCSI-3 SPI-2 Parallel Interface Specification*
- Complies with *the American National Standard for Information Systems SCSI-3 Fast-20*
- Reduces engineering effort of designing an interconnect to SCSI bus
- Has V/I characteristics that meet the SCSI bus drive requirements
- Provides for direct silicon interconnect to a SCSI transmission line
- On-chip 48 mA drivers
- 3.3 V V_{DD} (5-volt-tolerant)
- Bidirectional I/O transceiver that provides maximum flexibility in I/O path design
- Available in the G10 cell-based product families (0.35-micron drawn gate length, 0.29-micron effective channel length)
- Transfer rates up to 40 MHz
- Active negation SE driver

Specifications

The following subsections provide the specifications for the SCSI bidirectional universal LVD 3.3 V transceivers.

Figure 2 shows the schematic symbol for the bidirectional universal LVD transceiver.

Figure 2 Bidirectional Universal LVD Transceiver Logic Diagram



Name: BDLVDSCSIF

Description: SCSI 3.3 V bidirectional transceiver used with the SCSI-2, SCSI-3 10 MHz, SCSI-3 FAST-20, and SCSI-3 FAST-40 Buses

Coding Syntax: U(IOM, IOP, ZI, ZIDIFF, PORN, POP) = BDLVDSCSIF (IOM, IOP, A, B, EN, NEG, TN, ENDIFF, TNDIFF, PIM, PIP, DIFF, IDDTN, HTPLG)

Silicon Dimensions: 285.6 µm x 226.8 µm

Cell Placement Restrictions

The following cells are designed to be used with G10 technology:

- pvdd2_lvdscsi: To supply vdd2
- apvdd_lvdscsi: To supply analog V_{DD}
- apvss_lvdscsi: To supply analog V_{SS}
- pvdd_lvdscsi: To supply 3.3 V to the I/O
- pvss2_lvdscsi: To supply vss2
- dvdd_lvdscsi: Dummy cell for differential SCSI cells
- dvddil_lvdscsi: Left dummy interface cell
- dvddir_lvdscsi: Right dummy interface cell

The first five cells in this list supply vdd2, avdd, avss, 3.3 V I/O, and vss2 to the SCSI buffers. The dvdd_lvdscsi, dvddil_lvdscsi, and dvddir_lvdscsi cells provide a protection diode between vddlvdscsi and vssio. Adhere to the following guidelines when placing these cells:

1. At least one dummy cell must be placed at both ends of the SCSI section.
2. There must be at least one pvdd_lvdscsi, apvdd_lvdscsi, and apvss_lvdscsi cell per five SCSI buffers; one V_{SS} per two SCSI buffers.

Recommended Operating Conditions

Table 1 provides the recommended operating conditions for the bidirectional SCSI I/O Transceiver.

Table 1 Recommended Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Unit
V_{DD}	DC Supply Voltage	3.14	3.3	3.46	V
T_j	Junction Temperature	0	30	125	˚C

Table 2 provides the loading characteristics for the control portion of the bidirectional transceiver. Values are in standard loads.

Table 2 Bidirectional Universal LVD Transceiver's Loading Characteristic[1]

A	B	EN	TN	ENDIFF	TNDIFF	NEG	HTPLG	DIFF	IDDTN	PIM	PIP
3.5	1.2	0.8	1.5	2.2	3.1	0.9	0.9	9.8	5.5	13.9	1.6

1. One standard load = 0.0151775 pF.

Table 3 provides the AC timing for the bidirectional transceiver's input portion. These specifications are valid only for the commercial operating range: junction temperature = 0 ˚C to 125 ˚C, V_{DD} = 3.3 V ±5%.

Table 3 Bidirectional Universal LVD Transceiver's AC Delay Characteristics for Transmitters (ns)

Delay Path	Output	Capacitance Load (pF)			
		15	50	85	100
A to IOM	tpLH	3.98	4.77	5.48	5.77
	tpHL	3.79	4.58	5.19	5.42
	tpZL	6.87	7.66	8.36	8.64
	tpLZ	10.18	9.95	9.74	9.67
EN to IOM	tpZH	2.61	4.14	5.91	6.67
	tpZL	6.93	7.72	8.42	8.70
	tpLZ	10.20	9.97	9.76	9.69
	tpHZ	1.49	1.49	1.49	1.49
TN to IOM	tpZH	2.41	4.19	5.96	6.72
	tpZL	6.79	7.59	8.29	8.57
	tpLZ	10.11	9.88	9.67	9.59
	tpHZ	1.38	1.38	1.38	1.38

(Sheet 1 of 2)

Table 3 Bidirectional Universal LVD Transceiver's AC Delay Characteristics for Transmitters (ns), Continued

Delay Path	Output	Capacitance Load (pF)			
		15	50	85	100
ENDIFF to IOM	tpZH	1.68	3.08	4.25	4.69
	tpZL	5.08	7.27	9.60	10.60
	tpLZ	3.97	3.97	3.97	3.96
	tpHZ	5.51	5.51	5.51	5.51
TNDIFF to IOM	tpZH	1.71	3.10	4.24	4.67
	tpZL	5.00	7.22	9.56	10.56
	tpLZ	3.89	3.89	3.88	3.88
	tpHZ	5.43	5.43	5.43	5.43
A to IOP	tpLH	4.80	5.36	5.88	6.11
	tpHL	5.45	6.04	6.66	6.93
ENDIFF to IOP	tpZH	2.58	3.90	4.72	5.04
	tpZL	4.62	7.35	9.98	11.12
	tpLZ	8.74	8.74	8.75	8.75
	tpHZ	8.74	8.74	8.75	8.75
TNDIFF to IOP	tpZH	2.60	3.84	4.65	4.96
	tpZL	4.58	7.32	9.96	11.11
	tpLZ	8.66	8.66	8.67	8.67
	tpHZ	8.66	8.66	8.66	8.67
(Sheet 2 of 2)					

Note:
- V_{DD}, = 3.3 V, 25 ˚C.
- AC Timing measurements are made with T_r, T_f (0.5 V–2.3 V, 2.3 V–0.5 V) less than 6 ns.

Table 4 provides the AC timing for the receiver portion of the bidirectional transceiver. These specifications are valid only for the commercial operating range: junction temperature = 0 ˚C to 125 ˚C, V_{DD} = 3.3 V ±5%.

Table 4 Bidirectional Universal LVD Transceiver's AC Delay Characteristics for Receivers (ns)

Delay Path	Output	Standard Load (pF)					
		0	2	4	8	12	16
IOM to ZI	tpLH	0.55	0.58	0.61	0.67	0.72	0.78
	tpHL	0.28	0.31	0.34	0.39	0.43	0.43
IOM to ZIDIFF	tpLH	1.64	1.67	1.70	1.74	1.78	1.81
	tpHL	1.91	1.95	1.98	2.03	2.07	2.11
IOP to ZIDIFF	tpLH	1.68	1.71	1.73	1.78	1.81	1.85
	tpHL	1.88	1.91	1.94	1.99	2.03	2.08

SCSI Bidirectional LVD Transceiver, Single-Ended Mode

Input Portion of Bidirectional LVD Single-Ended Transceiver

Table 5 provides the truth table for the input portion.

Table 5 Bidirectional Transceiver's Input Portion Truth Table (Diff = 0), Single-Ended Mode

IOM	PIM	ZI	POM
0	X	0	1
1	0	1	1
1	1	1	0

Table 6 lists the DC characteristics for the bidirectional transceiver's input portion. These specifications are valid only for the commercial operating range: junction temperature = 0 ˚C to 125 ˚C, V_{DD} = 3.3 V ±5%.

Table 6 Bidirectional LVD Single-Ended Transceiver's Input Portion DC Characteristics for 3.3 V Signaling

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
V_{DD}	Supply Voltage		3.14	3.30	3.46	V
V_{ih}	Input High Voltage[1]	Signal FALSE State	1.9	–	5.25	V
V_{il}	Input Low Voltage	Referenced to V_{SS} Signal TRUE State	-0.5	–	1.0	V
V_{ik}	Input Clamp Voltage	V_{DD} = Min; I_i = -20 mA	–	–	-0.75	V
V_{th}	Threshold, High to Low		1.00	–	1.30	V
V_{tl}	Threshold, Low to High		1.60	–	1.90	V
V_{th}–V_{tl}	Hysteresis		300	600	–	mV
I_{il}	Low Level Input Current	V_i = 0.5 V, Power ON or Power OFF, except during Hot Plug	–	–	±10	µA
I_{ih}	High Level Input Current	V_i = 2.7 V, Power ON or OFF, except during Hot Plug	–	–	±10	µA
Iih.hp	Hot Plug High Level Current Peak	Transient duration to 10% of peak = 20 µs. Applies during physical insertion only.	–	–	+1.5	mA
C_p	Pin Capacitance	Package included	2.6	3.0	3.4	pF
R_i	Input Resistance		–	20	–	mΩ
T_j	Junction Temperature		0	–	125	˚C
I_{lu}	Latch-up Current	-2 V < V_{pin} < +8 V	–	–	±100	mA
ESD	Electrostatic Discharge	MIL-STD-883C, Method 3015.7, 100 pF at 1.5 kΩ	2001	–	–	V

1. Absolute maximum of 8.0 V.

Table 7 is the truth table for the output portion of the single-ended transceiver.

Table 7 Bidirectional LVD Single-Ended Output Portion Truth Table

NEG	A	B	TN	EN	IOM	IOP
0	X	0	X	1	High Z	0
0	X	0	0	X	High Z	0
0	0	0	1	0	0	0
0	1	0	1	0	1	0
1	X	0	X	1	High Z	0
1	X	0	0	X	High Z	0
1	0	0	1	0	0	0
1	1	0	1	0	High Z	0
X	X	1	X	X	X	1

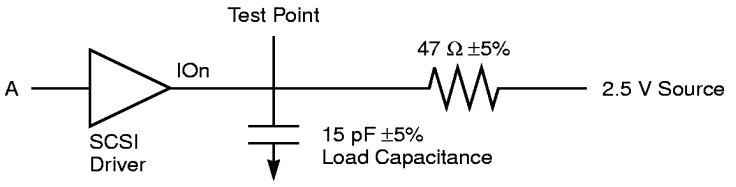
Table 8 provides the DC characteristics of the bidirectional LVD single-ended output portion of the transceiver.

Table 8 Bidirectional LVD Single-Ended Transceiver's Output Portion DC Characteristics for 3.3 V Signaling

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
V_{ol}	Output Low Voltage	When I_{oh} = 48 mA Signal TRUE State	0.0	–	0.5	V
V_{oh}	Output High Voltage	When I_{oh} = -7 mA Signal FALSE State	2.0	–	3.24	V
I_{oh}	Output Current	When V_{oh} = 2 V	7.5	19.2	19.5	mA
I_{il}	Low Level Input Current	High Z State: V_i = 0.5 V, Power ON or OFF, except during Hot Plug	–	–	±10	µA
I_{ih}	High Level Input Current	High Z State: V_i = 2.7 V, Power ON or OFF, except during Hot Plug	–	–	±10	µA
Iih.hp	Hot Plug High Level Current Peak	High Z State: Transient duration to 10% of peak = 20 µs. This applies to physical insertion only.	–	–	1.5	mA
C_p	Pin Capacitance	Package included	2.6	3.0	3.4	pF
I_l	Output Leakage	High Z State, V_{DD} = max	–	–	±10	µA
V_{DD}	Supply Voltage	V_{ol} and High Z only	3.14	3.30	3.46	V
T_j	Junction Temperature		0	–	125	°C
I_{lu}	Latch-up Current	-2 V < V_{pin} < +8 V	–	–	±100	mA
ESD	Electrostatic Discharge	MIL-STD-883C, Method 3015.7, 100 pF at 1.5 kΩ	2001	–	–	V

Figure 3 shows the timing test circuit for the single-ended output portion of the bidirectional transceiver.

Figure 3 SCSI Output Timing (Rise Time) Test Circuit



Input Portion of Bidirectional LVD Transceiver, Differential Mode

Table 9 shows the truth table for the input portion of the bidirectional LVD transceiver.

Table 9 Bidirectional LVD Transceiver's Input Portion Truth Table, Differential Mode (Diff = 1)

IOM	IOP	ZDIFF	POM	PIM	POP	PIP
X	X	Unspec	1	0	Unspec	X
1	X	Unspec	0	1	Unspec	X
0	X	Unspec	1	1	Unspec	X
X	X	Unspec	Unspec	X	1	0
X	1	Unspec	Unspec	X	0	1
X	0	Unspec	Unspec	X	1	1
IOP > IOM	IOP > IOM	1	1	0	Unspec	X
IOP > IOM	IOP > IOM	1	Unspec	1	Unspec	X
IOP > IOM	IOP > IOM	1	Unspec	X	1	0
IOP > IOM	IOP > IOM	1	Unspec	X	Unspec	1
IOM > IOP	IOM > IOP	0	1	0	Unspec	X
IOM > IOP	IOM > IOP	0	Unspec	1	Unspec	X
IOM > IOP	IOM > IOP	0	Unspec	X	1	0
IOM > IOP	IOM > IOP	0	Unspec	X	Unspec	1

Note:
1. X = don't care.
2. Unspec = Unspecified, an indeterminate output is acceptable.
3. IOM > IOP or IOM < IOP means that it is larger by the minimum sensitivity specified in the DC compliancy test table (Table 10).

Table 10 shows the DC compliancy specification for input levels to the differential transceiver.

Table 10 DC Compliancy Test Table

V_{iom}	V_{iop}	V_{is}	V_{icm}	zidiff
0.715	0.685	0.03	0.70	0
0.685	0.715	-0.03	0.70	1
1.815	1.785	0.03	1.8	0
1.785	1.815	-0.03	1.8	1
3.6	0	3.6	1.8	0
0	3.6	-3.6	1.8	1
3.955	-0.355	4.310	1.8	0
-0.355	3.955	-4.310	1.8	1

Table 11 lists the DC characteristics for the input portion of the bidirectional transceiver. These specifications are valid only for the commercial operating range: junction temperature = 0 ˚C to 125 ˚C, V_{DD} = 3.3 V ±5%.

Table 11 Bidirectional Transceiver's Input DC Characteristics (Differential)

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
V_{DD}	Supply Voltage		3.14	3.30	3.46	V
C_p	Pin Capacitance	Package included	2.6	3.0	3.4	pF
V_{ist}	V_{is} Threshold to detect a 1 or 0	Measured with 0.7 V < V_{icm} < 1.8 V; see Figure 4.	–	–	30	mV
V_{id}	Differential Input Voltage	Max values of V_{is}	-4.31	–	+4.31	V
T_j	Junction Temperature		0	–	125	˚C
I_{lu}	Latch-up Current	-2 V < V_{pin} < +8 V	–	–	±100	mA
ESD	Electrostatic Discharge	MIL-STD-883C, Method 3015.7, 100 pF at 1.5 kΩ	2001	–	–	V

Figure 4 shows the voltage and current definitions for the receiver portion of the bidirectional transceiver.

Figure 4 Receiver Voltage and Current Definitions

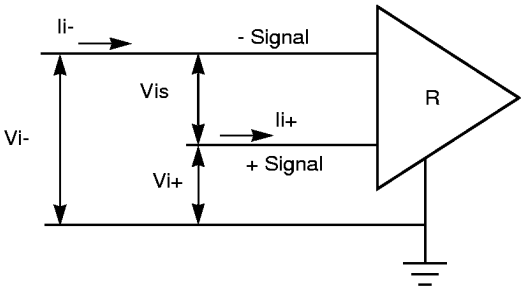


Table 12 is the truth table for the output of the bidirectional LVD in Differential Mode.

Table 12 Bidirectional LVD Output Portion Truth Table, Differential Mode (Diff = 1)

TNDIFF	ENDIFF	A	IOM	IOP
X	1	X	High Z	High Z
0	X	X	High Z	High Z
1	0	0	LOW	HIGH
1	0	1	HIGH	LOW

1. On a SCSI bus, a HIGH is negated, and a LOW is asserted.

Table 13 lists the DC characteristics for the output portion of the bidirectional transceiver. These specifications are valid only for the commercial operating range: junction temperature = 0 ˚C to 125 ˚C, V_{DD} = 3.3 V ±5%.

Table 13 Bidirectional Transceiver's Output DC Characteristics (Differential)

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
V_{DD}	Supply Voltage		3.14	3.30	3.46	V
T_j	Junction Temperature		0	–	125	˚C
I_{lu}	Latch-up Current	-2 V < V_{pin} < +8 V	–	–	±100	mA
C_p	Pin Capacitance	Package included	2.6	3.0	3.4	pF
| V_A | = | IOP - IOM |	Differential Output Voltages (asserted)	V1 = 0.957 V, V2 = 0.535 V and V1 = 1.949 V, V2 = 1.527 V; see Figure 5 and Figure 6.	270	–	780	mV
| Vn | = | IOP - IOM |	Differential Output Voltage (negated)	V1 = 0.957 V, V2 = 0.535 V and V1 = 1.949 V, V2 = 1.527 V; see Figure 5 and Figure 6.	260	–	640	mV
| V_A |	Differential Output Voltage (asserted)	For all combinations of V1 and V2 above; see Figures 5 and 6.	0.69 * | Vn | + 50	–	1.45 * | Vn | - 65	mV
V_{cm}	Offset Voltage (asserted)		0.7	–	1.8	V
V_{cm*}	Offset Voltage (negated)		0.7	–	1.8	V
| V_{cm} - V_{cm*} |	Difference in State Offset Voltage		–	–	50	mV
Io-s Io+s	Driver Short Circuit Current		-38	–	+38	mA
Vo-oc Vo+oc	Driver Open Circuit Voltage		0	–	3.6	V
T_r / T_f	Differential Driver Rise and Fall Times	V1 = 1.375 V, V2 = 0.807 V and V1 = 1.693 V, V2 = 1.125 V	1	–	–	ns
V_{cm} (pk-pk)	Dynamic Output Signal Balance		–	–	120	mV pk-pk
| i- | | i+ |	Driver /Receiver Output / Input Currents	V_{DD} = 0 V or V_{DD} = 3.15 - 3.45 V	–	–	20	µA
ESD	Electrostatic Discharge	MIL-STD-883C, Method 3015.7, 100 pF at 1.5 kΩ	2001	–	–	V

Figure 5 shows the voltage and current definitions for the driver portion of the bidirectional transceiver.

Figure 5 Driver Voltage and Current Definitions

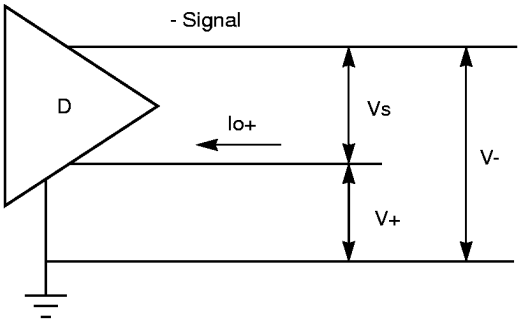
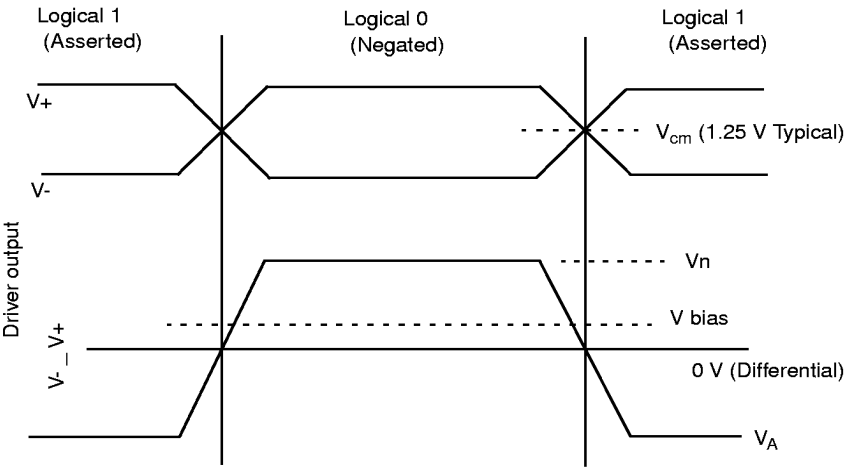


Figure 6 shows the bidirectional transceiver's signalling sense.

Figure 6 LVD SCSI Signalling Sense



DIFFSENSE Receiver

Name: DIFFSENS

Description: The LVD SCSI DIFFSENSE Receiver detects the voltage level on the SCSI bus DIFFSENSE line and informs the device of the transmission mode used by the bus (see Figure 7). It is capable of detecting single-ended, LVD SCSI, and HV differential modes.

Coding Syntax: Z(HVD, LVD, SE) = DIFFSENS(IDDTN, DSIN)

Silicon Dimensions: 96.6 µm x 81.2 µm

Figure 7 LVD SCSI DIFFSENSE Receiver Logic Diagram

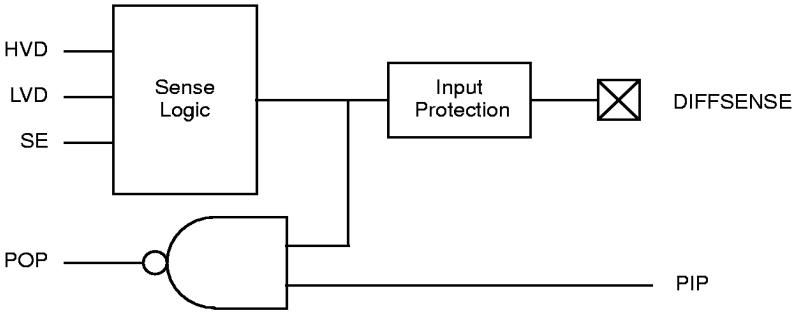


Table 14 provides the operating characteristics for the DIFFSENSE receiver.

Table 14 DIFFSENSE Operating Truth Table

DIFFSENSE Input Voltage	PIP	SE	HVD	LVD	POP
-0.5 V to 0.6 V	X	1	0	0	1
0.7 V to 1.9 V	X	0	0	1	Undefined
2.2 V to 5.5 V	0	0	1	0	1
2.2 V to 5.5 V	1	0	1	0	0

Table 15 provides the DC characteristics for the DIFFSENSE receiver.

Table 15 DIFFSENSE DC Characteristics

Symbol	Parameter	Min	Typ	Max	Units	Test Condition
V_{DD}	Supply Voltage	3.14	3.30	3.46	V	
C_p	Input Capacitance	–	4.5	–	pF	Package Included
T_j	Junction Temperature	0	–	125	°C	
I_{lu}	Latch-up Current	–	–	±100	mA	-2 V < V_{pin} < + 8 V
ESD	Electrostatic Discharge	2001	–	–	V	MIL-STD-883C, Method 3015.7, 100 pF at 1.5 kΩ

Power On Reset Cell

Name: SCSIPOR

Description: Provides power-up timing to the output and bidirectional cells. This cell must be used; only one is needed for all I/O transceivers.

Coding Syntax: U(HTPLG) = SCSIPOR(); for 3.3 V_{DD}

Silicon Dimensions: 226.8 µm high, 144.2 µm wide

Figure 8 shows the schematic symbol for the power on reset cell.

Figure 8 Power On Reset Cell

Notes

Notes

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Bidirectional 3.3 V Universal LVD Transceiver (G10™)
Datasheet Errata

Erratum Numbers

E000662

Revision

Not applicable

Date Code

Not applicable

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B15058

Problem Area (E000662)

Problem Description – Io–s, Io+s – Driver Short Circuit Current in Bidirectional Transceiver's Output DC Characteristics (Differential) on page 14, needs correction.

Suggested Solution – Correct the Io–s, Io+s – Driver Short Circuit Current in Bidirectional Transceiver's Output DC Characteristics (Differential) on page 14, to read:

Min – Typ – Max < 24 mA