SY88149NDL

1.25Gbps Burst-Mode Limiting Amplifier with Ultra-Fast Signal Assert Timing

General Description

The SY88149NDL is a high-sensitivity, burst-mode capable limiting post amplifier designed for Optical Line Terminal (OLT) receiver applications. The SY88149NDL satisfies the strict timing restrictions of the GPON standards by providing ultra-fast Loss-of-Signal (LOS) or Signal-Detect (SD) output. Auto Reset and Manual Reset options are provided to control LOS/SD output timing. For increased flexibility, this device also includes an option to select between LOS or SD output. The device can be connected to burst-mode capable transimpedance amplifiers (TIAs) using AC or DC coupling.

The SY88149NDL generates a high-gain LOS or SD LVTTL output. A programmable LOS/SD level set pin (LOS/SD_{LVL}) sets the sensitivity of the input amplitude detection. When LOS/SD SEL pin is left open or tied to Vcc, JAM is active high, SD is selected and asserts high if the input amplitude rises above the threshold sets by LOS/SD_{LVL} and de-asserts low otherwise. When LOS/SD SEL pin is set low or tied to GND, JAM is active low, LOS is selected and asserts low if the input amplitude rises above the threshold sets by LOS/SD_{LVL} and de-asserts high otherwise. The LOS/SD output can be fed back to the JAM input to maintain output stability under an invalid signal conditions. Typically, 4–5 dB SD hysteresis is provided to prevent chattering.

The SY88149NDL also features a selectable proprietary Noise Discriminator that aids by filtering out input signals that do not qualify as a 1.25Gbps GPON preamble signal in the initial startup phase. This feature minimizes false SD Asserts that can be triggered by random noise.

The SY88149NDL operates from a single +3.3V power supply, over temperatures ranging from –40°C to +85°C. With its wide bandwidth and high gain, signals up to 1.25Gbps and as small as 5mVpp can be amplified to drive devices with LVPECL inputs.

All support documentation can be found on Micrel's web site at: www.micrel.com.

Features

- <5ns SD Assert (LOS Deassert) time
- Option to AUTO RESET or manual RESET LOS/SD output
- Selectable LOS/SD output option
- High-sensitivity LOS/SD signal detect
- Low-noise LVPECL data outputs
- Squelching function to maintain output stability
- Programmable LOS/SD level set (LOS/SD_{LVL})
- 5mVpp input sensitivity
- 1.25Gbps operation
- Single 3.3V power supply
- Available in a 16-pin (3mm × 3mm) QFN® package

Applications

- GE-PON/GPON OLT
- Gigabit Ethernet
- Fibre Channel
- OC-3/12/24 SONET/SDH
- High-gain line driver and line receiver
- Low-gain TIA interface

Markets

- FTTH PON
- Datacom/Telecom
- Optical transceiver

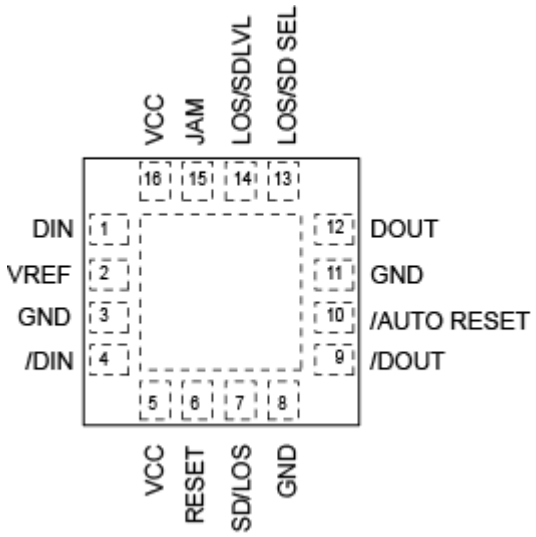
Ordering Information

Part Number	Package Type	Operating Range	Package Marking
SY88149NDLMG	Lead-Free QFN-16	Industrial	149N with Pb-Free bar-line indicator
SY88149NDLMG TR[1]	Lead-Free QFN-16	Industrial	149N with Pb-Free bar-line indicator

Notes:

1. Tape and Reel.

Pin Configuration



16-Pin QFN® (QFN-16)

Truth Table for SD/LOS Select and Noise Discriminator function

LOS/SDSEL PIN	LOS/SD SELECTION	NOISE DISCRIMINATOR	INPUT TO JAM	OUTPUTS
0Ω to VCC	SD	Enabled	HIGH	Enabled
0Ω to VCC	SD	Enabled	LOW	Disabled
16KΩ to VCC	SD	Disabled	HIGH	Enabled
16KΩ to VCC	SD	Disabled	LOW	Disabled
16KΩ to GND	LOS	Disabled	HIGH	Disabled
16KΩ to GND	LOS	Disabled	LOW	Enabled
0Ω to GND	LOS	Enabled	HIGH	Disabled
0Ω to GND	LOS	Enabled	LOW	Enabled

Pin Description

Pin Number	Pin Name	Pin Function
1, 4	DIN, /DIN	Differential Data Inputs. If AC-coupled, terminate each pin to V_{REF} with 50Ω.
2	VREF	Reference Voltage Output. Typically V_{CC} – 1.3V.
3, 11, 8	GND	Device Ground. Exposed pad must be soldered (or equivalent) to the same potential as the ground pins.
10	/AUTO RESET	LVTTL Input. This pin is internally connected to a 25kΩ pull-up resistor and defaults to HIGH. When this pin is LOW or tied to ground, the /AUTO RESET function is enabled and SD deasserts or LOS asserts within 120ns (typical) after the last high-to-low transition of the burst input. When this pin is left floating or tied high, the AUTO RESET function is disabled and the SD deassert or LOS assert must be forced by using the manual RESET function.
5, 16	VCC	Positive power supply. Bypass with 0.1uF | | 0.01uF low ESR capacitors. 0.01uF capacitors should be as close as possible to VCC pins.
6	RESET	LVTTL Input. Apply a high-level signal (>2V) to this pin to reset the SD deassert time or LOS assert within 5ns. RESET defaults to LOW if left floating. If the /AUTO RESET function is not used, this RESET function needs to be used to quickly deassert the SD or assert LOS. This pin is internally connected to a 25kΩ pull-down resistor and defaults to LOW.
7	SD/LOS	LVTTL Output. Signal detect (SD) asserts high when the data input amplitude rises above the threshold sets by SD_{LVL}. Conversely, loss-of-signal (LOS) deasserts low when the data input amplitude rises above the threshold set by LOS/SD_{LVL}.
12, 9	DOUT, /DOUT	LVPECL Outputs. When JAM disables the device, output DOUT is forced to logic LOW and output /DOUT is forced to logic HIGH.
13	LOS/SD SEL	Allows the user to select between whether LOS or SD is outputted on the LOS/SD pin. Also controls the polarity of the JAM input. When SD is selected, JAM is active HIGH and LOS/SD (Pin 7) operates as signal detect. Conversely, when LOS is selected, JAM is active LOW and LOS/SD operates as loss-of-signal. This pin is internally connected to a 25kΩ pull-up resistor and defaults to HIGH (SD output selected).
14	LOS/SDLVL	Voltage Input. Sets the LOS/SD level. A resistor from this pin to V_{CC} sets the threshold for the data input amplitude at which LOS/SD will be asserted.
15	JAM	LVTTL Input. This JAM input acts as a squelch function and switches its polarity depending on LOS/SD SEL status. When LOS is selected, this pin is active LOW. When SD is selected, this pin is Active HIGH. To create a squelch function, connect JAM to LOS/SD. When JAM disables the device, output Q is forced to logic LOW and output /Q is forced to logic HIGH. Note that this input is internally connected to a 25kΩ pull-up resistor.

Absolute Maximum Ratings[1]

Supply Voltage (V_{CC}) ..... 0V to +4.0V
Input Voltage (DIN, /DIN) ..... 0 to V_{CC}
Output Current (I_{OUT})
  Continuous ..... ±50mA
  Surge ..... ±100mA
EN Voltage ..... 0 to V_{CC}
V_{REF} Current ..... -800µA to +500µA
SD_{LVL} Voltage ..... V_{REF} to V_{CC}
Lead Temperature (soldering, 20s) ..... 260°C
Storage Temperature (T_s) ..... –65°C to +150°C

Operating Ratings[2]

Supply Voltage (V_{CC}) ..... +3.0V to +3.6V
Ambient Temperature (T_A) ..... –40°C to +85°C
Junction Temperature (T_J) ..... –40°C to +125°C
Junction Thermal Resistance[3]
  QFN® (θ_{JA}) Still-Air ..... 60°C/W
  QFN® (Ψ_{JB}) Junction-to-Board ..... 38°C/W

DC Electrical Characteristics

V_{CC} = 3.0 to 3.6V; T_A = –40°C to +85°C, typical values at V_{CC} = 3.3V, T_A = 25°C.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
I_{CC}	Power Supply Current	No output load		77	105	mA
LOS/SD_{LVL}	LOS/SD_{LVL} Voltage		V_{REF}		V_{CC}	V
V_{OH}	LVPECL Output HIGH Voltage	50Ω to V_{CC} – 2V	V_{CC} – 1.085	V_{CC} – 0.955	V_{CC} – 0.880	V
V_{OL}	LVPECL Output LOW Voltage	50Ω to V_{CC} – 2V	V_{CC} – 1.830	V_{CC} – 1.705	V_{CC} – 1.555	V
I_{OFFSET}	Input Offset Voltage				1	mV
$V_{IHCMR(Diff)}$	Common-Mode Range (Differential)	Note 4	GND + 1.4		Vcc	
$V_{IHCMR(SE)}$	Common-Mode Range (Single Ended)	Note 4	GND + 1.2		Vcc	V
V_{REF}	Reference Voltage		V_{CC} – 1.48	V_{CC} – 1.32	V_{CC} – 1.16	V
I_{DIN}	Input Sink Current (DIN & /DIN)	No Input Load	1.5	7	14	uA

LVTTL DC Electrical Characteristics

V_{CC} = 3.0 to 3.6V; T_A = –40°C to +85°C, typical values at V_{CC} = 3.3V, T_A = 25°C.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{IH}	LVTTL Input HIGH Voltage		2.0			V
V_{IL}	LVTTL Input LOW Voltage				0.8	V
I_{IH_JAM}	JAM Input HIGH Current	V_{IN} = V_{CC} V_{IN} = 2.7V			20 20	µA
I_{IL_JAM}	JAM Input LOW Current	V_{IN} = 0.5V	–0.3			mA
I_{IH_AR}	/AUTORESET Input HIGH Current	V_{IN} = V_{CC} V_{IN} = 2.7V			100 20	µA
I_{IL_AR}	/AUTORESET Input LOW Current	V_{IN} = 0.5V	–0.3			mA
I_{IH_RESET}	RESET Input HIGH Current	V_{IN} = V_{CC} V_{IN} = 2.7V			300 250	µA
I_{IL_RESET}	RESET Input LOW Current	V_{IN} = 0.5V	0			mA
V_{OH}	SD/LOS Output HIGH Level	I_{OH} = –100uA	2.1	2.7		V
V_{OL}	SD/LOS Output LOW Level	I_{OL} = 100uA		0.35	0.5	V

AC Electrical Characteristics

V_{CC} = 3.0V to 3.6V; R_{LOAD} = 50Ω to V_{CC} – 2V; T_A = –40°C to +85°C.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
t_r, t_f	Output Rise/Fall Time (20% to 80%)	Note 5			260	ps
t_{JAM}	JAM Enable/Disable Time				2	ns
$t_{AUTORESET}$	SD Deassert or LOS Assert with Auto Reset Enabled.		100	120	150	ns
t_{RESET}	RESET Disable Time	Note 6			5	ns
t_{ON}	SD Assert Time/LOS Deassert time				5	ns
t_{JITTER}	Deterministic Random	Note 7 Note 8		15 5		ps_{PP} ps_{RMS}
V_{ID}	Differential Input Voltage Swing	Figure 1	5		1800	mV_{PP}
V_{OD}	Differential Output Voltage Swing	V_{ID} ≥18mV_{PP}		1500		mV_{PP}
SD_{AL} /LOS_{DL}	Low SD Assert/LOS De- Assert Level	$R_{LOS/SDLVL}$ = 10kΩ, Notes (9, 10)		4		mV_{PP}
SD_{DL}/LOS_{AL}	Low SD Deassert /LOS Assert Level	$R_{LOS/SDLVL}$ = 10kΩ, Notes (10, 12)		3		mV_{PP}
HYS_L	Low SD/LOS Hysteresis	$R_{LOS/SDLVL}$ = 10kΩ, Notes (11, 12)		5		dB
SD_{AM}/LOS_{DM}	Medium SD Assert/LOS Deassert Level	$R_{LOS/SDLVL}$ = 5kΩ, Notes (10, 12)	9.5	12.5	16	mV_{PP}
SD_{DM}/LOS_{AM}	Medium SD Deassert /LOS Assert Level	$R_{LOS/SDLVL}$ = 5kΩ, Notes (10,12)	5	7	8.5	mV_{PP}
HYS_M	Medium SD/LOS Hysteresis	$R_{LOS/SDLVL}$ = 5kΩ, Notes (11, 12)	3.0	4.5	6.5	dB
SD_{AH}/LOS_{DH}	High SD Assert/LOS De- Assert Level	$R_{LOS/SDLVL}$ = 50Ω, Notes (10, 12)	27	35	45	mV_{PP}
SD_{DH}/LOS_{AH}	High SD Deassert/ LOS Assert Level	$R_{LOS/SDLVL}$ = 50Ω, Notes (10, 12)	15	21	28	mV_{PP}
HYS_H	High SD/LOS Hysteresis	$R_{LOS/SDLVL}$ = 50Ω, Notes (11, 12)	2.0	3	6	dB
B_{-3dB}	3dB Bandwidth			750		MHz
$A_{V(Diff)}$	Differential Voltage Gain			48		dB
S_{21}	Single-Ended Small-Signal Gain			42		dB

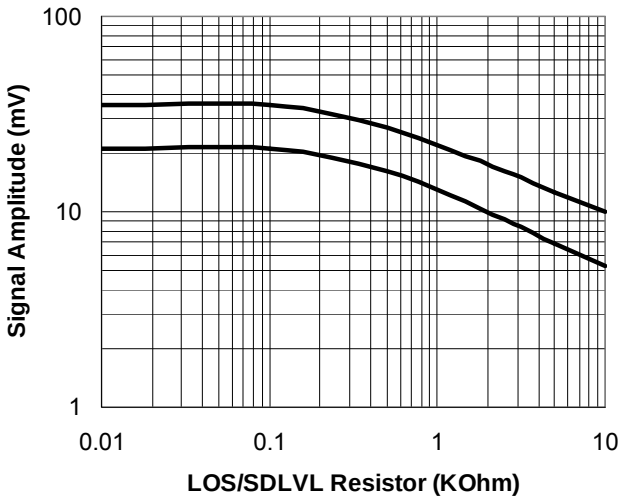
Notes:

1. Permanent device damage may occur if absolute maximum ratings are exceeded. This is a stress rating only and functional operation is not implied at conditions other than those detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
2. The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.
3. Thermal performance assumes the use of a 4-layer PCB. Exposed pad must be soldered to the device's most negative potential on the PCB.
4. VIHCMR is defined as common mode range of the VIH level on DIN and /DIN. It is the most positive level of the differential input signal when driven differentially or is the reference level on Din\ when being driven single ended.
5. Amplifier in limiting mode. Input is a 200MHz square wave.
6. The time between applying RESET and outputs being disabled.
7. Deterministic jitter measured using 1.25Gbps K28.7 pattern, V_{ID} = 10mV_{PP}.
8. Random jitter measured using 1.25Gbps K28.7 pattern, V_{ID} = 10mV_{PP}.
9. SD is the opposite polarity of LOS. Therefore, an SD Assert parameter is equivalent to a LOS deassert parameter and vice versa.
10. See "Typical Operating Characteristics" for a graph showing how to choose a particular $R_{LOS/SDLVL}$ for a particular assert and its associated deassert amplitude.
11. This specification defines electrical hysteresis as 20log(SD assert/SD deassert). The ratio between optical hysteresis and electrical hysteresis is found to vary between 1.5 and 2 depending upon the level of received optical power and ROSA characteristics. Based upon that ratio, the optical hysteresis corresponding to the electrical hysteresis range 3dB – 6dB, shown in the AC Characteristics table, will be 1.5dB-4dB optical hysteresis.
12. All SD Assert (LOS De-Assert) level, SD De-assert (LOS Assert) level and Hysteresis specifications listed above are specified using a 1010 PON Preamble data pattern at the specified data rate of 1.288 Gbps.

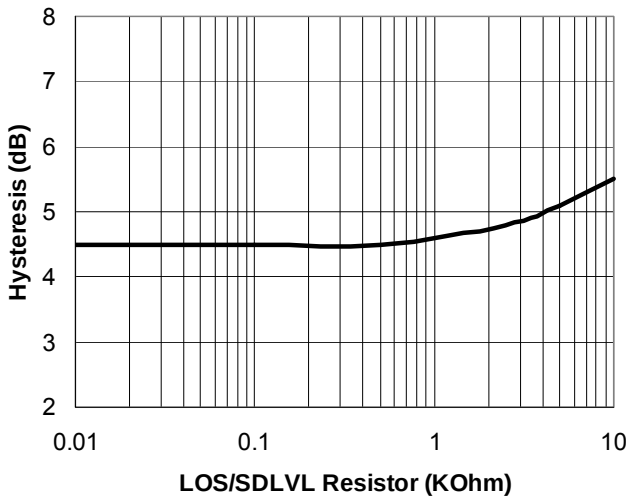
Typical Operating Characteristics

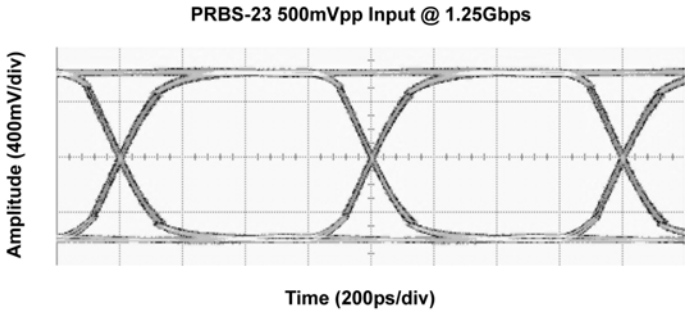
V_{CC} = 3.3V, T_A = 25°C, R_L = 50Ω to V_{CC} – 2V, unless otherwise stated.

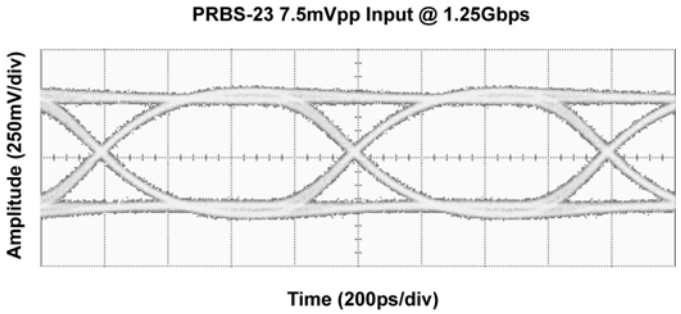
LOS Assert/De-Assert Levels

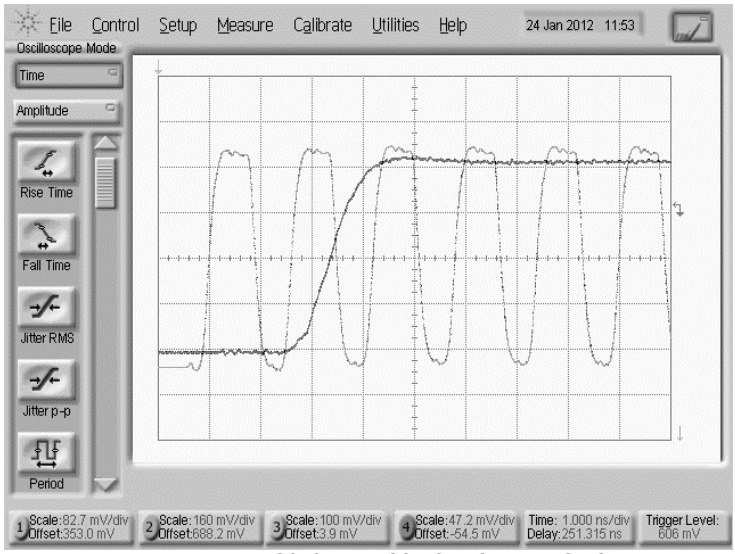


LOS/SD Hysteresis

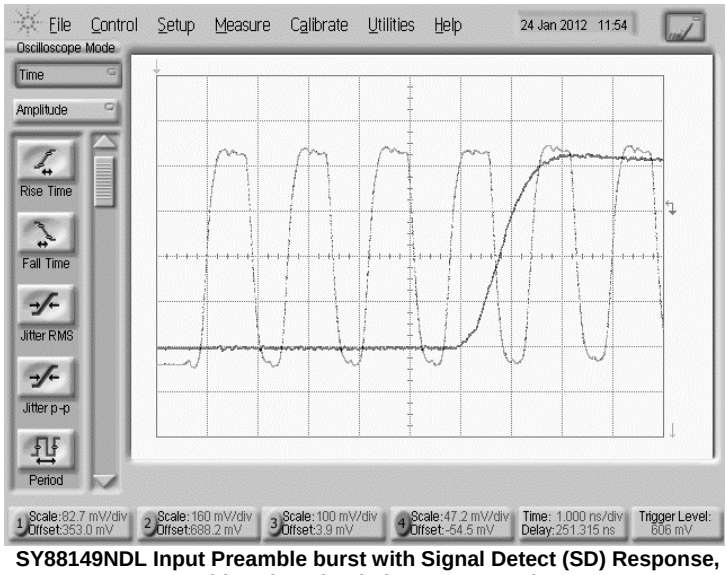






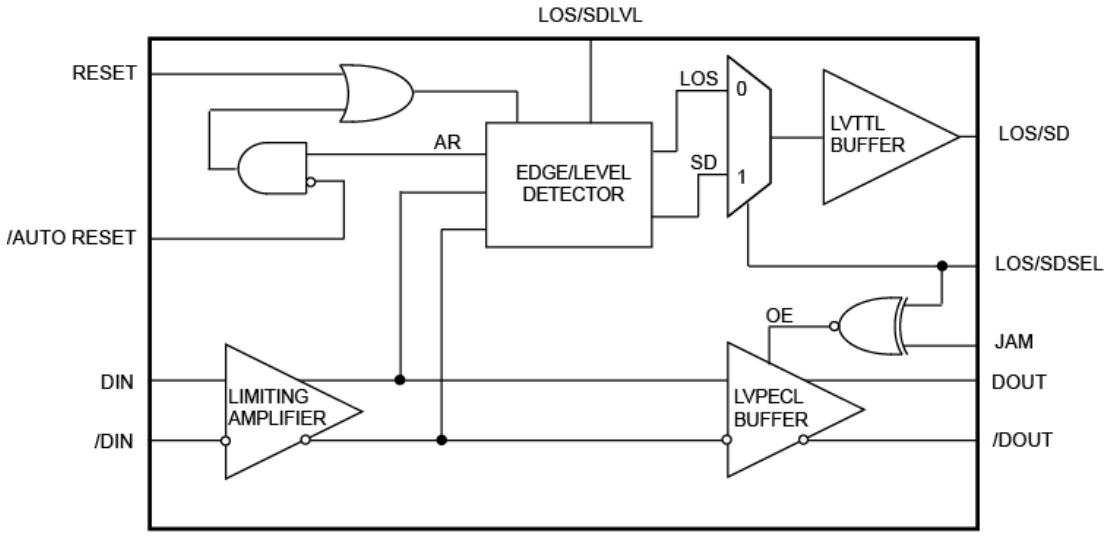


SY88149NDL Input Preamble burst with Signal Detect (SD) Response, with Noise Discriminator disengaged



SY88149NDL Input Preamble burst with Signal Detect (SD) Response, with Noise Discriminator engaged

Functional Block Diagram



Detailed Description

The SY88149NDL is a high-sensitivity limiting post amplifier which operates on a +3.3V power supply over the industrial temperature range. Signals with data rates up to 1.25Gbps and as small as 5mVpp can be amplified. Depending on the LOS/SD SEL option, the SY88149NDL can generate an SD or LOS output, and allow feedback to the JAM input for output stability. LOS/SD_{LVL} sets the sensitivity of the input amplitude detection.

To satisfy the stringent timing requirements of the GPON specifications, the signal detect circuit offers 5ns SD assert (LOS deassert) time and the option to deassert SD (assert LOS) using the /AUTO RESET or manual RESET function. When /AUTO RESET is enabled, SD deasserts/LOS asserts automatically within 120ns after the last high-to-low transition of the input burst. When the /AUTORESET function is disabled, the SD deassert/LOS assert time can be reset by using the provided RESET pin.

Input Buffer

Figure 2 shows a simplified schematic of the input stage. The high sensitivity of the input amplifier allows signals as small as 5mVpp to be detected and amplified. The input buffer can allow input signals as large as $1800mV_{PP}$. Input signals are linearly amplified with a typically 48dB differential voltage gain until the outputs reach $1500mV_{PP}$ (typical). Applications requiring the SY88149NDL to operate with high-gain should have the upstream TIA placed as close as possible to the SY88149NDL's input pins. This ensures the best performance of the device.

Output Buffer

The SY88149NDL's LVPECL output buffer is designed to drive 50Ω lines. The output buffer requires appropriate termination for proper operation. An external 50Ω resistor to V_{CC} – 2V for each output pin provides this. Figure 3 shows a simplified schematic of the output stage

Loss of Signal/Signal Detect

The SY88149NDL generates a chatter-free Signal-Detect (SD) or Loss of Signal (LOS) LVTTL output, as shown in Figure 4. A highly-sensitive signal detect circuit is used to determine that the input amplitude is too small to be considered a valid input. LOS asserts high if the input amplitude falls below the threshold sets by LOS/SDLVL and deasserts low otherwise. SD asserts high if the input amplitude rises above threshold set by LOS/SDLVL and deasserts low otherwise. LOS/SD can be fed back to the JAM input to maintain output stability under the absence of an invalid signal condition Typically, a 3dB to 4 dB hysteresis is provided to minimize or prevent chattering.

LOS/SD Level Set

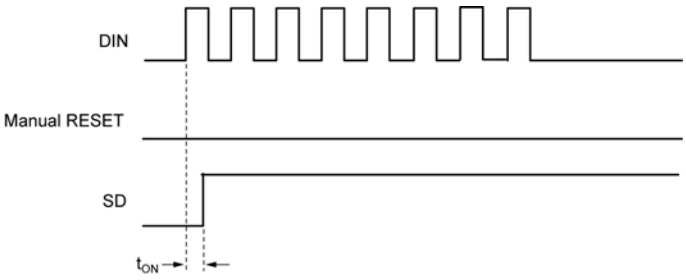
A programmable LOS/SD level pin (LOS/SD_{LVL}) sets the threshold of the input amplitude detection. Connecting an external resistor between V_{CC} and LOS/SD_{LVL} sets the voltage at LOS/SD_{LVL}. This voltage ranges from V_{CC} to V_{REF}. The external resistor creates a voltage divider between V_{CC} and V_{REF}, as shown in Figure 5. Set the LOS/SD_{LVL} voltage closer to V_{REF} or more sensitive LOS/SD detection or closer to V_{CC} for higher inputs.

Note that the SY88149NDL is designed for use in the burst mode PON application, where every burst is preceded with several bytes of a 1010 PON preamble pattern. Therefore, the SD Assert (LOS De-assert) is designed to trigger on the first few bits of this preamble pattern and therefore the SD/LOS thresholds outlined in the AC electrical characteristics are specified using this preamble pattern. Once the SD is Asserted (LOS De-asserted), the SD is De-asserted (LOS Asserted) only by the application of a Manual RESET or an AUTO RESET if the Auto Reset is activated, The auto reset asserts a reset approximately 120 nS after the last negative going transition of the data as explained earlier.

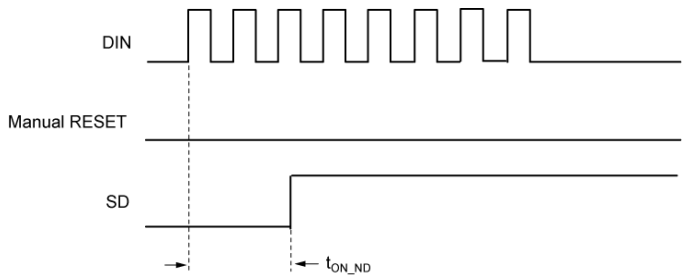
Noise Discriminator

The noise discriminator feature is intended for the high-gain burst-mode TIAs where noise can trigger a false LOS deassert or SD assert while no input data is present. The noise discriminator will filter input data through a series of specialized circuitry that will only trigger LOS/SD on the rising edge of a valid PON 1.244 Gbps preamble bit stream (10101). The SY88149NDL noise discriminator is designed to accept a 1.244 Gbps +/-300 MBPS preamble burst. Any other bit pattern will be rejected. If this part is used at any other data rate, the Noise Discriminator should be disengaged. The noise discriminator, implemented in the edge detector circuit, can be selected or bypassed by selecting the proper resistor value using the settings at LOS/SDSEL pin. Refer to the "Truth Table for SD/LOS select and Noise Discriminator function" found on page 2 for more detailed information.

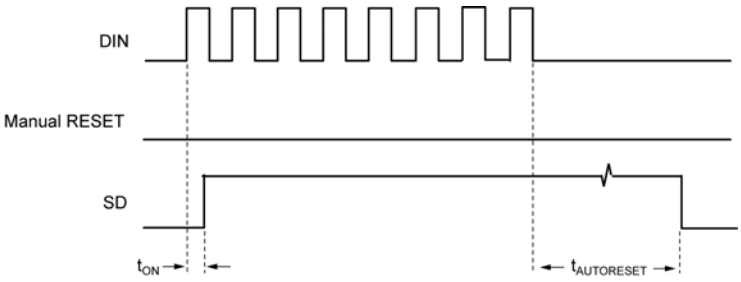
Timing Diagrams



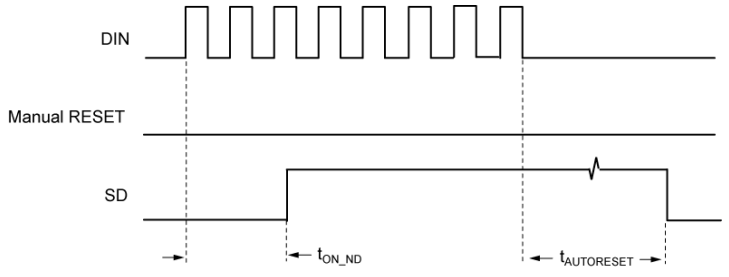
a) No manual RESET & /AutoReset tied HIGH (Noise Discriminator OFF)



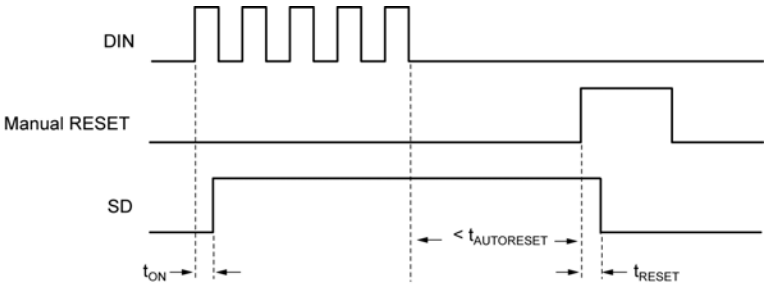
b) No manual RESET & /AutoReset tied HIGH (Noise Discriminator ON)



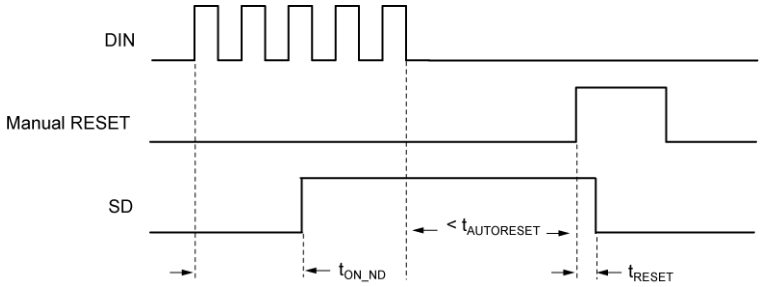
c) No manual RESET & /AutoReset tied LOW (Noise Discriminator OFF)



d) No manual RESET & /AutoReset tied LOW (Noise Discriminator ON)

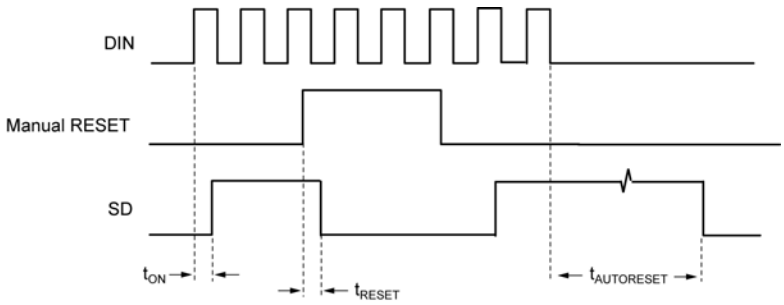


e) Manual RESET & /AutoReset tied HIGH or LOW (Noise Discriminator OFF)

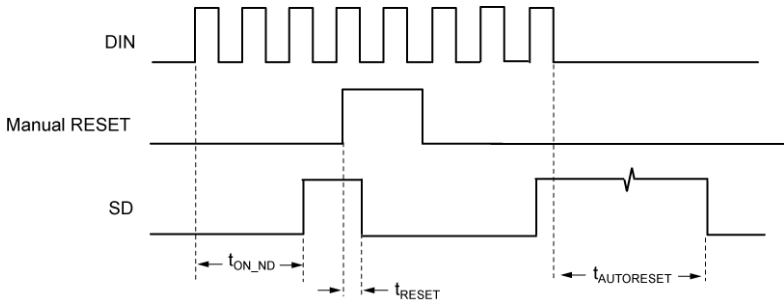


f) Manual RESET & /AutoReset tied HIGH or LOW (Noise Discriminator ON)

hbwhelp@micrel.com or (408) 955-1690



g) Manual RESET Pulse & /AutoReset tied LOW (Noise Discriminator OFF)



h) Manual RESET Pulse & /AutoReset tied LOW (Noise Discriminator ON)

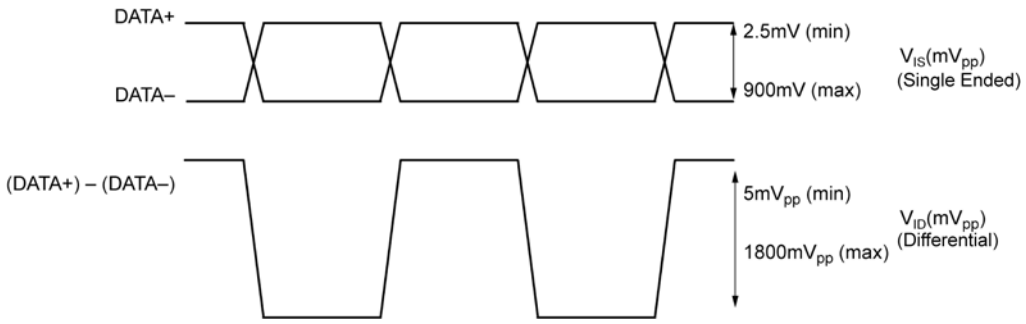


Figure 1. VIS (single ended) and VID (differential) Definition

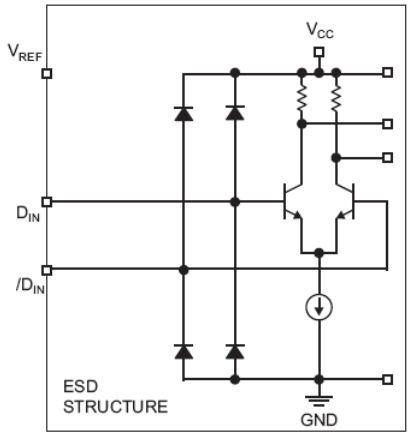


Figure 2. Simplified Input Structure

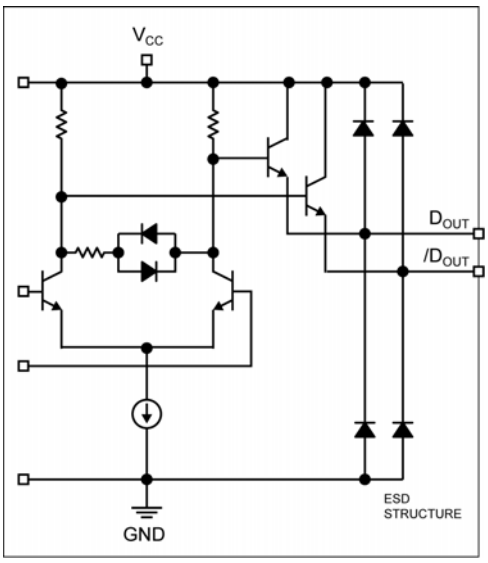


Figure 3. Simplified Output Structure

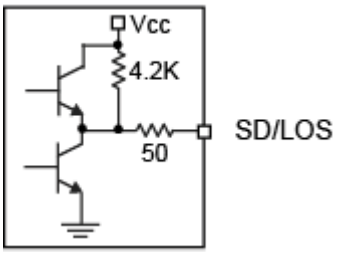


Figure 4. Simplified LOS/SD Output Structure

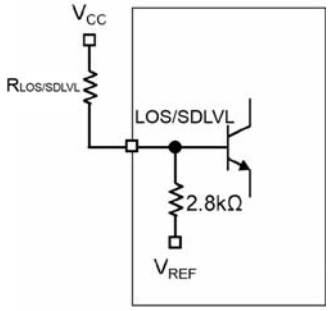
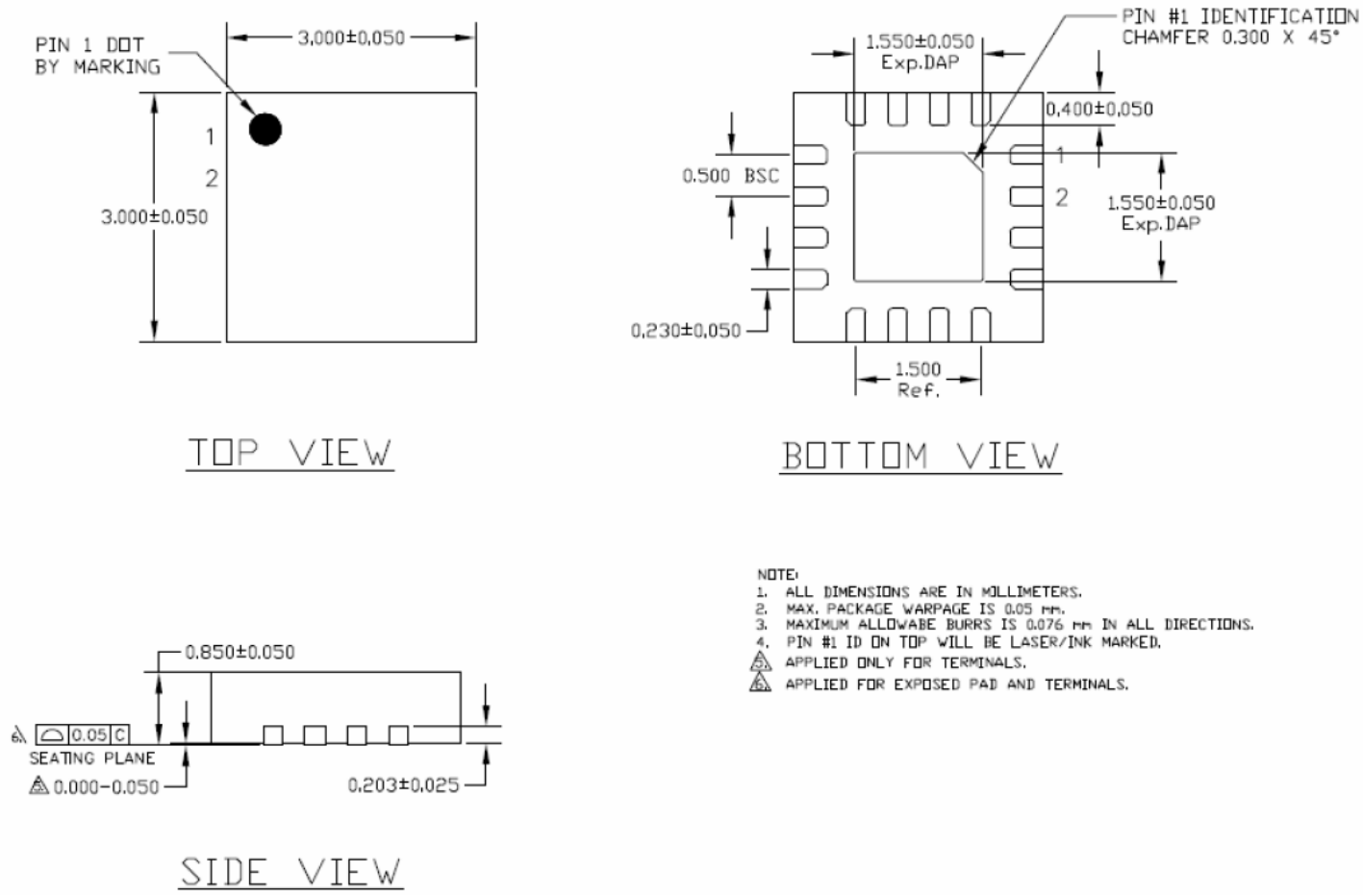


Figure 5. Simplified LOS/SD_{LVL} Setting Circuit

Package Information



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HBW Datasheet Revision History

Part Number: SY88149NDL

Initial Release Date:

Rev.	Date	Revisions	Reason	Engineer
A	4/29/10	Made from SY88149HL DS	New version of part. Contains fixed JAM Tpd & RESET Hysteresis	D. Cheng
	5/11/10	Changed Package Marking to "149A" from "149H"	Mistake left over from 149HL	D. Cheng
	8/31/10	Revised AC-table specs • LOS Assert/Deassert • Hysteresis • Removed RESET Hyst. • Changed 3dB value	Design Tweak to address chattering issue	D. Cheng
	01/7/11	Added Noise Discriminator description	New feature	D. Cheng
	01/8/11	Multiple error fixes	After peer review	D. Cheng
	2/11/11	Added Dieter's comments	Only partially completed. Waiting for bench char	D. Cheng
	6/9/2011	Signoff	Signoff purposes	D. Cheng
	7/1/2011	Implement sign-off changes	Recommended changes from reviewers	D. Cheng
	7/28/11	Change in EPN from SY88149HAL to SY88149NDL	Misc. changes in organization, figures and EPN change	D. Cheng
	8/11/11	Add LOS Deassert time waveforms and other art	Finalize Data sheet.	G.Brown
	9/01/11	Add comments in Noise Discriminator Description	Add Comments to ND description and do minor cleanup	GBrown
	9/31/11	Update Icc	Update Icc typical to 77 mA/105 mA max	GBrown
	01/27/12	Update to make compatible with SY88349NDL	Upgrade waveforms and add notes and updates to DC/AC tables	GBrown