

**features**

- Multi-Rate Operation from 155 Mbps Up to 3.3 Gbps
- 106-mW Power Consumption
- Input Offset Cancellation
- High Input Dynamic Range
- Output Disable
- Output Polarity Select
- CML Data Outputs
- Receive Signals Strength Indicator (RSSI)
- Loss of Signal Detection

- Single 3.3-V Supply
- Surface Mount Small Footprint 3 mm × 3 mm 16-Pin QFN Package

**applications**

- SONET/SDH Transmission Systems at OC3, OC12, OC24, OC48
- 1.0625-Gbps and 2.125-Gbps Fibre Channel Receivers
- Gigabit Ethernet Receivers

**description**

The ONET3301PA is a versatile high-speed limiting amplifier for multiple fiber optic applications with data rates up to 3.3 Gbps.

This device provides a gain of about 50 dB, which ensures a fully differential output swing for input signals as low as 3 mV<sub>p-p</sub>.

The high input signal dynamic range ensures low jitter output signals even when overdriven with input signal swings as high as 1200 mV<sub>p-p</sub>.

The ONET3301PA comprises a loss of signals detection as well as a received signal strength indicator.

The part is available in a small footprint 3 mm × 3 mm 16-pin QFN package and requires a single 3.3-V supply.

This power efficient limiting amplifier dissipates less than 106 mW typical. It is characterized for operation from -40°C to 85°C.

**available options**

T <sub>A</sub>	PACKAGED DEVICE	FEATURES
-40°C to 85°C	ONET3301PARGT	3.3-Gbps limiting amplifier with LOS and RSSI



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# ONET3301PA 155-Mbps TO 3.3-Gbps LIMITING AMPLIFIER

SLLS603 – MARCH 2004

## block diagram

A simplified block diagram of the ONET3301PA is shown in Figure 1.

These compact, low power 3.3-Gbps limiting amplifier consists of a high-speed data path with offset cancellation block, a loss of signal and RSSI detection block, and a bandgap voltage reference and bias current generation block.

The limiting amplifier requires a single 3.3-V supply voltage. All circuit parts are described in detail below.

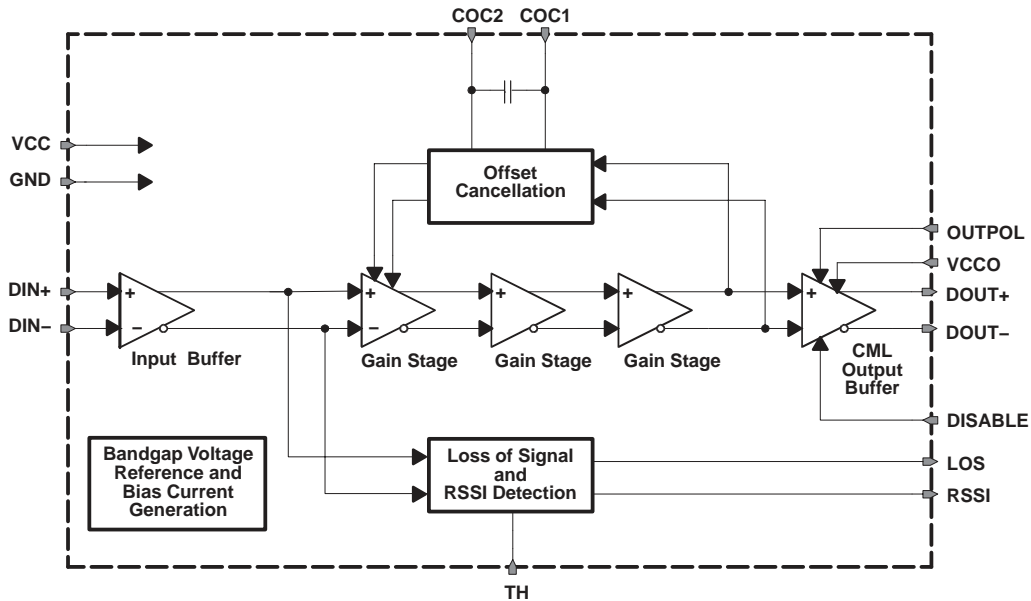


Figure 1. Block Diagram

## high-speed data path

The high-speed data signal is applied to the data path by means of the input signal pins DIN+/DIN-. The data path consists of the input stage with  $2 \times 50\text{-}\Omega$  on-chip line termination to VCC, three gain stages, which provide the required typical gain of about 50 dB, and a CML output stage. The amplified data output signal is available at the output pins DOUT+/DOUT-, which provide  $2 \times 50\text{-}\Omega$  back-termination to VCCO. The output stage also includes a data polarity switching function, which is controlled by the OUTPOL input and a disable function, controlled by the signal applied to the DISABLE input pin.

An offset cancellation compensates inevitable internal offset voltages and thus ensures proper operation even for small input data signals.

The low frequency cutoff is as low as 45 kHz with the built-in filter capacitor.

For applications, which require even lower cutoff frequencies, an additional external filter capacitor may be connected to the COC1/COC2 pins.

## loss of signal and RSSI detection

The output signal of the input buffer is monitored by the loss of signal and RSSI detection circuitry. In this block a signal is generated, which is linear proportional to the input amplitude over a wide input voltage range. This signal is available at the RSSI output pin.

Furthermore, this circuit block compares the input signal to a threshold, which can be programmed by means of an external resistor connected to the TH pin. If the input signal falls below the specified threshold, a loss of signal is indicated at the LOS pin.

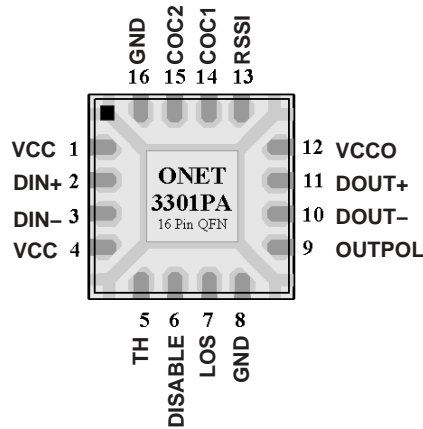
### bandgap voltage and bias generation

The ONET3301PA limiting amplifier is supplied by a single 3.3-V  $\pm 10\%$  supply voltage connected to the VCC and VCCO pins. This voltage is referred to ground (GND).

An on-chip bandgap voltage circuitry generates a supply voltage independent reference from which all other internally required voltages and bias currents are derived.

### package

For the ONET3301PA a small footprint 3 mm  $\times$  3 mm 16-pin QFN package is used, with a lead pitch of 0,5 mm. The pin out is shown in Figure 2.



**Figure 2. Pinout of ONET3301PA in a 3 mm  $\times$  3 mm 16-Pin QFN Package**

### terminal functions

The following table shows a pin description for the ONET3301PA in a 3 mm  $\times$  3 mm 16-pin QFN package.

TERMINAL		TYPE	DESCRIPTION
NAME	NO.		
VCC	1, 4	Supply	3.3-V $\pm 10\%$ supply voltage
DIN+	2	Analog in	Noninverted data input. On-chip 50- $\Omega$ terminated to VCC
DIN-	3	Analog in	Inverted data input. On-chip 50- $\Omega$ terminated to VCC
TH	5	Analog in	LOS threshold adjustment with resistor to GND.
DISABLE	6	CMOS in	Disables CML output stage when set to high level.
LOS	7	CMOS out	High level indicates that the input signal amplitude is below the programmed threshold level.
GND	8, 16, EP	Supply	Circuit ground. Exposed die pad (EP) must be grounded.
OUTPOL	9	CMOS in	Output data signal polarity select (internally pulled up): Setting to high level or leaving pin open selects normal polarity. Low level selects inverted polarity.
DOUT-	10	CML out	Inverted data output. On-chip 50- $\Omega$ back-terminated to VCCO
DOUT+	11	CML out	Noninverted data output. On-chip 50- $\Omega$ back-terminated to VCCO
VCCO	12	Supply	3.3-V $\pm 10\%$ supply voltage for output stage
RSSI	13	Analog out	Analog output voltage proportional to the input data amplitude. Indicates the strength of the received signal (RSSI).
COC1	14	Analog	Offset cancellation filter capacitor terminal 1. Connect an additional filter capacitor between this pin and COC2 (pin 15). To disable the offset cancellation loop connect COC1 and COC2 (pins 14 and 15).
COC2	15	Analog	Offset cancellation filter capacitor terminal 2. Connect an additional filter capacitor between this pin and COC1 (pin 14). To disable the offset cancellation loop connect COC1 and COC2 (pins 14 and 15).

# ONET3301PA

## 155-Mbps TO 3.3-Gbps LIMITING AMPLIFIER

SLLS603 – MARCH 2004

### absolute maximum ratings

over operating free-air temperature range unless otherwise noted†

		VALUE	UNIT
V <sub>CC</sub> , V <sub>CCO</sub>	Supply voltage, See Note 1	-0.3 to 4	V
V <sub>DIN+</sub> , V <sub>DIN-</sub>	Voltage at DIN+, DIN-, See Note 1	0.5 to 4	V
V <sub>TH</sub> , V <sub>DISABLE</sub> , V <sub>LOS</sub> , V <sub>OUTPOL</sub> , V <sub>DOUT+</sub> , V <sub>DOUT-</sub> , V <sub>RSSI</sub> , V <sub>COC1</sub> , V <sub>COC2</sub>	Voltage at TH, DISABLE, LOS, OUTPOL, DOUT+, DOUT-, RSSI, COC1, and COC2, See Note 1	-0.3 to 4	V
V <sub>COC_DIFF</sub>	Differential voltage between COC1 and COC2	±1	V
V <sub>DIN_DIFF</sub>	Differential voltage between DIN+ and DIN-	±2.5	V
I <sub>LOS</sub>	Current into LOS	-1 to 9	mA
I <sub>DIN+</sub> , I <sub>DIN-</sub> , I <sub>DOUT+</sub> , I <sub>DOUT-</sub>	Continuous current at inputs and outputs	-25 to 25	mA
ESD	ESD rating at all pins	2	kV (HBM)
T <sub>J(max)</sub>	Maximum junction temperature	125	°C
T <sub>stg</sub>	Storage temperature range	-65 to 85	°C
T <sub>A</sub>	Characterized free-air operating temperature range	-40 to 85	°C
T <sub>L</sub>	Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds	260	°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to network ground terminal.

### recommended operating conditions

	MIN	TYP	MAX	UNIT
Supply voltage, V <sub>CC</sub> , V <sub>CCO</sub>	3	3.3	3.6	V
Operating free-air temperature, T <sub>A</sub>	-40		85	°C

### dc electrical characteristics

over recommended operating conditions (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V <sub>CC</sub> , V <sub>CCO</sub>	Supply voltage	3	3.3	3.6	V
I <sub>CC</sub>	Supply current		32	40	mA
V <sub>OD</sub>	Differential data output voltage swing		0.25	10	mV <sub>p-p</sub>
		600	780	1200	mV <sub>p-p</sub>
r <sub>IN</sub> , r <sub>OUT</sub>	Data input/output resistance		50		Ω
RSSI output voltage	Input = 2 mV <sub>p-p</sub> , R <sub>RSSI</sub> ≥ 10 kΩ		100		mV
	Input = 80 mV <sub>p-p</sub> , R <sub>RSSI</sub> ≥ 10 kΩ		2800		
RSSI linearity	20-dB input signal, V <sub>IN</sub> ≤ 80 mV <sub>pp</sub>		±3%	±8%	
V <sub>(IN_MIN)</sub>	Data input sensitivity		3	5	mV <sub>p-p</sub>
V <sub>(IN_MAX)</sub>	Data input overload	1200			mV <sub>p-p</sub>
	CMOS input high voltage	2.1			V
	CMOS input low voltage			0.6	V
	LOS high voltage	I <sub>SINK</sub> = -30 μA	2.4		V
	LOS low voltage	I <sub>SOURCE</sub> = 1 mA		0.4	V
	LOS hysteresis	2 <sup>23</sup> -1 PRBS (at 2.5 Gbps and 155 Mbps)	2.5	4.5	dB
V <sub>TH</sub>	LOS assert threshold range	2 <sup>23</sup> -1 PRBS (at 2.5 Gbps and 155 Mbps)		2-40	mV <sub>p-p</sub>
PSNR	Power supply noise rejection	f < 2 MHz	26		dB



**ac electrical characteristics**

over recommended operating conditions (unless otherwise noted) typical operating condition is at  $V_{CC} = 3.3\text{ V}$  and  $T_A = 25^\circ\text{C}$

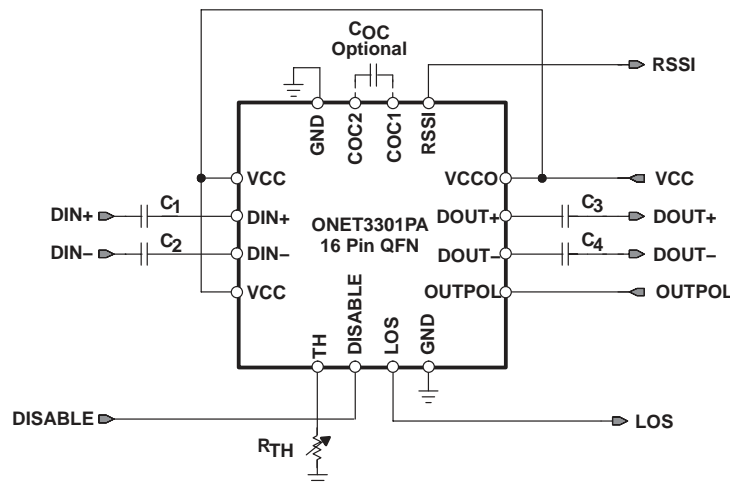
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Low frequency -3-dB bandwidth	$C_{OC} = \text{open}$		45	70	kHz
	$C_{OC} = 2.2\text{ nF}$		0.8		
Data rate		3.3			Gb/s
VNI Input referred noise			180		$\mu\text{VRMS}$
DJ Deterministic jitter, See Note 2	K28.5 pattern at 3.3 Gbps		8.5	25	$\text{ps}_{\text{p-p}}$
	223-1 PRBS equivalent pattern at 2.7 Gbps		9.3	30	
	K28.5 pattern at 2.1 Gbps		7.8	25	
	223-1 PRBS equivalent pattern at 155 Mbps		25	50	
RJ Random jitter	Input = 5 mVpp		6.5		$\text{ps}_{\text{RMS}}$
	Input = 10 mVpp		3		
$t_r$ Output rise time	20% to 80%		60	85	ps
$t_f$ Output fall time	20% to 80%		60	85	ps
$t_{\text{DIS}}$ Disable response time			20		ns
$t_{\text{LOS}}$ LOS assert/deassert time		2		100	$\mu\text{s}$

NOTE 2: Deterministic jitter does not include pulse-width distortion due to residual small output offset voltage.

**APPLICATION INFORMATION**

Figure 3 shows the ONET3301PA connected with an ac-coupled interface to the data signal source as well as to the output load.

Besides the ac-coupling capacitors  $C_1$  through  $C_4$  in the input and output data signal lines, the only required external component is the LOS threshold setting resistor  $R_{\text{TH}}$ . In addition, an optional external filter capacitor ( $C_{\text{OC}}$ ) may be used if a low cutoff frequency is desired.



**Figure 3. Basic Application Circuit With AC-Coupled I/Os**



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