



# TLD4012

## ADSL LINE DRIVER USING TRIPATH DIGITAL POWER PROCESSING (DPP™) TECHNOLOGY

Technical Information

Revision 2.0a – May 2002

### GENERAL DESCRIPTION

The TLD4012 is an ADSL line driver that provides very low power consumption and low distortion in a very small package as a result of Tripath's proprietary power processing technology. This device accepts differential input signals from an analog front-end (AFE), and can be used in full-rate (G.dmt), or G.lite systems. This TLD4012 offers a low power consumption of 650mW for full-rate, full-power, CO-side, FDM (non-overlapped) transmissions.

### APPLICATIONS

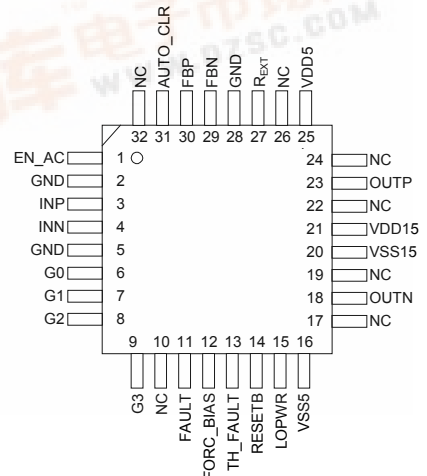
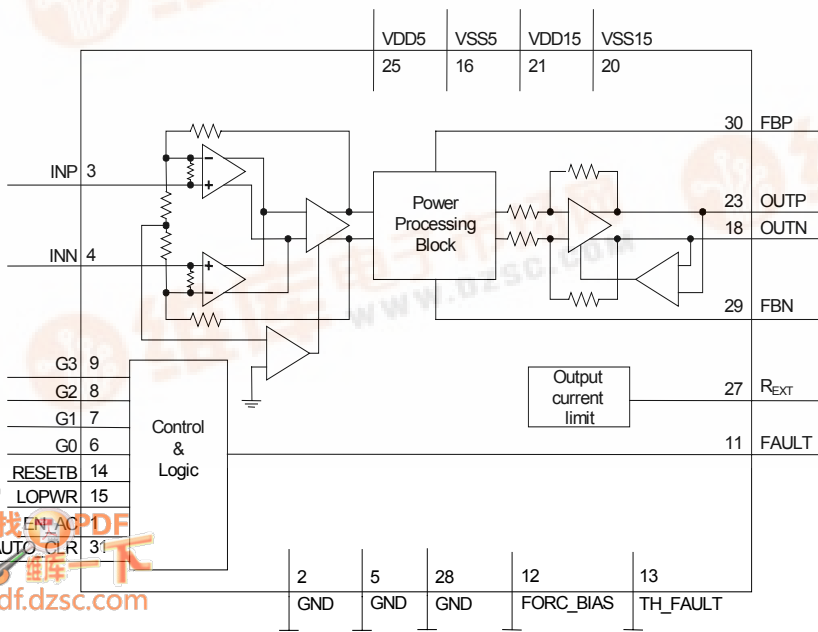
- Full-rate or G.lite line cards
- DSLAMs
- DLC equipment
- Central office switches

### BENEFITS

- Reduced line card power
- Reduced system power
- Increased line card density
- More ports per cubic foot of system space
- Improved system performance
- Simplifies thermal management on PCB
- Improved reliability
- Flexible solution

### FEATURES

- Tripath Proprietary Power Processing technology
- Very low power consumption
- $P_{CONS}$ (Full-rate ADSL) = 650 mW (typ)
- $P_{CONS}$  (G.lite) = 390 mW (typ)
- Low distortion
  - Spurious free dynamic range = -80 dBc 26kHz to 138kHz,  $R_{LINE}=100\Omega$ ,  $P_{LINE}=19.8dBm$
  - Third harmonic distortion = -83 dBc at  $f = 100$  kHz, -82 dBc at  $f = 500$  kHz, -63 dBc at  $f = 1$  MHz,  $V_{OUT} = 10Vpp$  (differential),  $70\Omega$  load
- 500 mA minimum output current into a  $71\Omega$  load
- Digitally programmable gain (from 12.8 to 27.8 dB in 1 dB steps)
- Low-power mode -130 mW typical (line terminated -allows reception of incoming signals)
- Disabled mode - 10 mW typical (no line termination)
- Over-temperature and over-current protection with Fault output
- 5x5 mm 32-pin TQFP with exposed die pad



(Top View)



## OVERVIEW

TLD4012 is a low-power, low-distortion ADSL line driver. This driver offers power consumption ranging from 600mW to 650mW, and provides active, or synthetic, output impedance matching to reduce power consumption. This driver supports an impedance synthesis factor of 2.55 (refer to Figure 1 in the “Test/Applications Circuits” section of this document). The table below summarizes the total power consumption of this device for FDM and overlapped transmissions. Power consumption is reduced by using +/-14V supplies for VDD15/VSS15.

High supplies VDD15/VSS15	Power consumption FDM (non-overlapped) (19.8dBm)	Power consumption overlapped (20.4dBm)
+/- 14.0 V	650 mW	710 mW
+/- 15.0 V	675 mW	740 mW

Power consumption values given above, and in the following specifications, are for total power consumed from the supplies. This includes power dissipated in the device and power delivered to the load, where the load includes both the line and the matching resistors. Power dissipation in the driver can be determined by subtracting power delivered to the load (line and matching resistors) from the power consumption given in the specifications. The power consumption provided above does not account for loading due to the hybrid which will vary with application.

With +/-14V supplies, the maximum output swing,  $V_{OUTMAX}$ , is at least  $40V_{PPDIFF}$  over process, temperature and a 5% supply tolerance. This is sufficient for full-power FDM signals with a PAR of 6.45. Note that when using +/-14V supplies with a 5% tolerance the worst-case spurious free dynamic range in the receiving band, and intermodulation distortion may be degraded slightly from the values given in the specifications below. When using 14V nominal supplies the maximum degradation expected when the +/-14V supplies are 5% low (minimum +/-13.3V) versus +/-15V supplies 5% low (minimum +/-14.25V) is less than 4dB worse case.

All other minimum and maximum specifications in the tables that follow are valid from +/-13.3 to +/-15.75V on VSS15/VDD15. This allows the use of +/-14V supplies with a 5% tolerance for VSS15/VDD15.

Lower PAR (peak-to-average ratio) values allow the high voltage supplies (VSS15 and VDD15) to be reduced further, thus reducing power consumption. For example, for a 5.3 PAR VSS15/VDD15 can be reduced to +/-12V. This will reduce power consumption to about 600mW for full-rate, 19.8dBm ADSL FDM (non-overlapped) transmissions. Contact Tripath regarding use of the TLD4012 below +/-13.3V.

The recommended values for the line-matching resistors,  $R_S$ , and the recommended transformer turns ratios to properly match the line are (see Figure 1 in “Test/Application” section below):

$$R_S = 10\Omega$$

$$N = 1:1.4$$

The 2.55 synthesis factor of the TLD4012 and the values above for  $R_S$  and N will result in a match to the 100 $\Omega$  line impedance. The synthesis factor, k, is defined as the factor by which the line driver multiplies the line-matching resistor,  $R_S$ .

If your application can take advantage of higher synthesis factors, contact Tripath regarding options that can reduce power consumption still further.

**ABSOLUTE MAXIMUM RATINGS**

SYMBOL	PARAMETER	Value	UNITS
V <sub>DD5</sub>	Positive 5V Supply Voltage	+ 6	V
V <sub>SS5</sub>	Negative 5V Supply Voltage	- 6	V
V <sub>DD15</sub>	Positive 15V Supply Voltage	+ 18	V
V <sub>SS15</sub>	Negative 15V Supply Voltage	- 18	V
T <sub>J</sub>	Maximum Junction Temperature	150	°C
T <sub>A</sub>	Operating Free-air Temperature Range	-40 to +85	°C
T <sub>STORE</sub>	Storage Temperature Range	-55 to 150	°C
T <sub>SOLDER</sub>	Manual soldering for three seconds Reflow soldering for five seconds	350 245	°C
I <sub>OUT</sub>	Output current limit, OOUTP or OOUTN	1.1	A
V <sub>IN</sub>	Input voltage, INP or INN	V <sub>SS5</sub> to V <sub>DD5</sub>	V
V <sub>CMR</sub>	Common mode input voltage range	V <sub>SS5</sub> to V <sub>DD5</sub>	V

**Notes:**

1. Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.
2. The absolute value of V<sub>DD5</sub> and V<sub>SS5</sub> must always be less than or equal to the absolute value of V<sub>DD15</sub> and V<sub>SS15</sub>.
3. **The TLD4012 incorporates an exposed die pad on the underside of its package. This acts as a heat sink and must be connected to a copper plane on the printed circuit board for proper heat dissipation. Failure to do so may result in exceeding the maximum junction temperature which could permanently damage the device. This copper plane must be connected to V<sub>SS15</sub>. See the Application Information section of this document for additional information.**
4. Application must insure that V<sub>SS15</sub> is applied before V<sub>SS5</sub>. A clamp diode connected between V<sub>SS5</sub> and V<sub>SS15</sub> can be used to insure proper application of supply voltages to the TLD4012 (see Test/Application Circuits of this document). Note that only one diode is needed per board for multi-channel line cards, but diode selection should account for the increased current transient that the diode must carry for multiple channels. If the +/-5V rail's rise time is fast, for example in applications in which the driver's supplies might be hot-plugged, this method may not be sufficient and supply sequencing may be necessary.

**RECOMMENDED OPERATING CONDITIONS**

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNITS
V <sub>DD5</sub>	Positive 5V Supply Voltage	+ 4.75	+ 5	+ 5.25	V
V <sub>SS5</sub>	Negative 5V Supply Voltage	- 5.25	- 5	- 4.75	V
V <sub>DD15</sub>	Positive 15V Supply Voltage	+ 13.3	+ 15	+ 15.75	V
V <sub>SS15</sub>	Negative 15V Supply Voltage	- 15.75	- 15	- 13.3	V
V <sub>IH</sub>	High-level Input Voltage, all digital inputs	2.7		+V <sub>DD5</sub>	V
V <sub>IL</sub>	Low-level Input Voltage, all digital inputs	0		0.8	V
I <sub>ODLEAK</sub>	Open drain leakage current, FAULT output			1	μA
I <sub>ODMAX</sub>	Open drain sink current at V <sub>OL</sub> =0.4V max, FAULT output	1			mA

Note: Recommended Operating Conditions indicate conditions for which the device is functional. See Electrical Characteristics for guaranteed specific performance limits.

**ELECTRICAL CHARACTERISTICS**

Unless otherwise specified,  $T_A = 25^\circ\text{C}$ ,  $V_{DD5} = +5\text{V}$ ,  $V_{SS5} = -5\text{V}$ ,  $V_{DD15} = +15\text{V}$ ,  $V_{SS15} = -15\text{V}$ . Also, see Test/Application Circuits. See functional description for details regarding synthetic output impedance. Minimum and maximum limits are guaranteed but may not be 100% tested.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
$P_{\text{CONS1}}$	Power Consumption	$R_{\text{LOAD}} = 71\Omega$ , $P_{\text{OUT}} = 154\text{ mW}$ , Full-rate, overlapped ADSL signal, line power = 110 mW (20.4 dBm), with synthetic output impedance (see Fig. 1)		740		mW
$P_{\text{CONS3}}$	Power Consumption, no signal	$R_{\text{LOAD}} = 50\Omega$ , No Input Signal, LOPWR = Low (see Fig. 1)		250		mW
$P_{\text{CONS4}}$	Power Consumption, no signal, low power mode	$R_{\text{LOAD}} = 50\Omega$ , No Input Signal, LOPWR = High (see Fig. 1)		130		mW
$P_{\text{CONS5}}$	G.Lite	$R_{\text{LOAD}} = 71\Omega$ , $P_{\text{OUT}} = 58\text{ mW}$ , G.Lite signal, line power = 41.6 mW (16.2 dBm). See Fig. 1.		390		mW
$P_{\text{CONS6}}$	Disable mode	RESETB = Low		10		mW
$I_{\text{DD5}}$	Operating Current VDD5	$R_{\text{LOAD}} = 71\Omega$ , $P_{\text{OUT}} = 154\text{ mW}$ , Full-rate, overlapped ADSL signal with synthetic output impedance (see Fig. 1)		47.0		mA
$I_{\text{SS5}}$	Operating Current VSS5	$R_{\text{LOAD}} = 71\Omega$ , $P_{\text{OUT}} = 154\text{ mW}$ , Full-rate, overlapped ADSL signal with synthetic output impedance (see Fig. 1)		49.0		mA
$I_{\text{DD15}}$	Operating Current VDD15	$R_{\text{LOAD}} = 71\Omega$ , $P_{\text{OUT}} = 154\text{ mW}$ , Full-rate, overlapped ADSL signal with synthetic output impedance (see Fig. 1)		8.0		mA
$I_{\text{SS15}}$	Operating Current VSS15	$R_{\text{LOAD}} = 71\Omega$ , $P_{\text{OUT}} = 154\text{ mW}$ , Full-rate, overlapped ADSL signal with synthetic output impedance (see Fig. 1)		9.5		mA
$I_{\text{q1}}$	Quiescent Current (VDD5 and VSS5)	$R_{\text{LOAD}} = 71\Omega$ , No input signal, LOPWR = Low		21.7		mA
$I_{\text{q2}}$	Quiescent Current (VDD15 and VSS15)	$R_{\text{LOAD}} = 71\Omega$ , No input signal, LOPWR = Low		1.1		mA
$I_{\text{q1LP}}$	Quiescent Current (VDD5 and VSS5), low power mode	$R_{\text{LOAD}} = 71\Omega$ , No input signal, LOPWR = High		11.0		mA
$I_{\text{q2LP}}$	Quiescent Current (VDD15 and VSS15), low power mode	$R_{\text{LOAD}} = 71\Omega$ , No input signal, LOPWR = High		0.68		mA
$V_{\text{BG}}$	Band-gap Voltage			1.28		V
$V_{\text{OUTmax}}$	Differential Output Voltage, peak-to-peak differential	Gain = 17.8 to 27.8 dB, $R_{\text{LOAD}} = 71\Omega$ Gain = 12.8 to 16.8 dB, $R_{\text{LOAD}} = 71\Omega$	42 20			V
$I_{\text{OUTmax}}$	Differential Output Current	$R_{\text{LOAD}} = 71\Omega$	500			mA
$I_{\text{SC}}$	Short-circuit Output Current	$R_{\text{EXT}} = 24\text{k}\Omega$		800		mA
$V_{\text{IO}}$	Differential Input Offset Voltage			600		$\mu\text{V}$
$\Delta V_{\text{OS}}$	Offset Voltage Drift			30		$\mu\text{V}/^\circ\text{C}$
$V_{\text{OSHI}}$	Differential Output Offset Voltage	Gain = 27.8dB, EN_AC = High, $5\text{k}\Omega$ across INN and INP	-100		100	mV
$I_{\text{b}}$	Input Bias Current	EN_AC = Low		0.5		$\mu\text{A}$
$\Delta I_{\text{b}}$	Differential Input Bias Current			0.2		$\mu\text{A}$
$R_{\text{DIFF}}$	Differential Input Resistance			800		$\text{k}\Omega$
$C_{\text{DIFF}}$	Differential Input Capacitance			2		pF
$R_{\text{OUTLP}}$	Output Resistance (while in Low-power mode)	LOPWR = High		0.5		$\Omega$

**PERFORMANCE CHARACTERISTICS**

Unless otherwise specified,  $T_A = 25^\circ\text{C}$ ,  $V_{DD5} = +5\text{V}$ ,  $V_{SS5} = -5\text{V}$ ,  $V_{DD15} = +15\text{V}$ ,  $V_{SS15} = -15\text{V}$ . Also, see Test/Application Circuit. Minimum and maximum limits are guaranteed but may not be 100% tested.

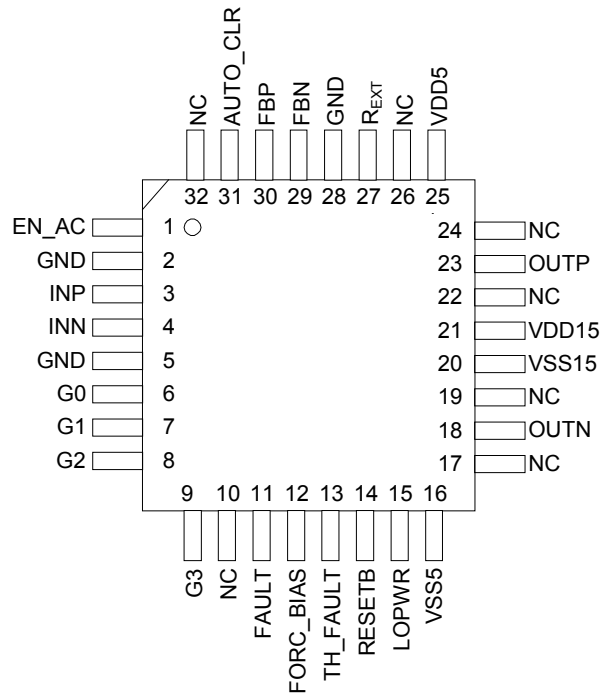
SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNITS
BW <sub>SS</sub>	Small-signal Bandwidth, -3 dB	Gain = 20.8dB, $V_{OUT} = 1V_{PPDIFF}$			10		MHz
SFDR	Spurious Free Dynamic Range in the receive band with respect to -40dBm ADSL transmit signal	Gain = 20.8 dB, $R_{LINE} = 100\Omega$ , $P_{LINE} = 20.4 \text{ dBm}$ , $f = 26 \text{ kHz to } 138 \text{ kHz}$			-80		dB
IMD	Intermodulation Distortion	Gain = 22.8dB $10V_{PPDIFF}$ each tone $f = 1.025\text{MHz}$ , $\Delta f = 50\text{kHz}$	@ 50 kHz @ 100 kHz SFDR >1MHz		-84 -84 -75		dBc
HD2	2 <sup>nd</sup> Harmonic Distortion	Gain = 17.8 to 27.8dB $R_{LOAD} = 71\Omega$ $V_{OUT} = 10V_{PPDIFF}$	$f = 100 \text{ kHz}$ $f = 500 \text{ kHz}$ $f = 1 \text{ MHz}$		-90 -77 -70		dBc
HD3	3 <sup>rd</sup> Harmonic Distortion	Gain = 17.8 to 27.8dB $R_{LOAD} = 71\Omega$ $V_{OUT} = 10V_{PPDIFF}$	$f = 100 \text{ kHz}$ $f = 500 \text{ kHz}$ $f = 1 \text{ MHz}$		-83 -82 -63		dBc
HD5	5 <sup>th</sup> Harmonic Distortion	Gain = 17.8 to 27.8dB $R_{LOAD} = 71\Omega$ $V_{OUT} = 10V_{PPDIFF}$	$f = 100 \text{ kHz}$ $f = 500 \text{ kHz}$ $f = 1 \text{ MHz}$		-93 -67 -55		dBc
SR	Slew Rate	$V_{OUT}$ from -10V to +10V, measured from -7.5V to +7.5V, Gain = 20.8 dB			200		V/ $\mu$ s
e <sub>N</sub>	Input Noise Voltage	Gain = 20.8dB, $f = 10 \text{ KHz}$			8		nV/ $\sqrt{\text{Hz}}$
i <sub>N</sub>	Input Noise Current	Gain = 20.8dB, $f = 10 \text{ kHz}$			2.9		pA/ $\sqrt{\text{Hz}}$
e <sub>NOTOT</sub>	Overall Output Noise Voltage	Gain = 20.8dB, $f = 30\text{kHz to } 1.1\text{MHz}$ , $R_{IN} = 5k\Omega$			188		nV/ $\sqrt{\text{Hz}}$
CMRR	Common Mode Rejection Ratio	Gain = 27.8 dB $V_{IN} = 100 \text{ mV}_{PP}$ EN AC = High	@ 100 kHz @ 500 kHz @ 1 MHz	65	83 70 65		dB
PSRR <sub>VDD5</sub>	Power Supply Rejection Ratio, VDD5	Gain = 22.8 dB $V_{SUPPLYAC} = 100 \text{ mV}_{PP}$	@ 100 kHz @ 500 kHz @ 1 MHz		70 60 50		dB
PSRR <sub>VSS5</sub>	Power Supply Rejection Ratio, VSS5	Gain = 22.8 dB $V_{SUPPLYAC} = 100 \text{ mV}_{PP}$	@ 100 kHz @ 500 kHz @ 1 MHz		60 52 45		dB
PSRR <sub>VDD15</sub>	Power Supply Rejection Ratio, VDD15	Gain = 22.8 dB $V_{SUPPLYAC} = 100 \text{ mV}_{PP}$	@ 100 kHz @ 500 kHz @ 1 MHz		82 76 67		dB
PSRR <sub>VSS15</sub>	Power Supply Rejection Ratio, VSS15	Gain = 22.8 dB $V_{SUPPLYAC} = 100 \text{ mV}_{PP}$	@ 100 kHz @ 500 kHz @ 1 MHz		75 59 51		dB
$\Delta$ Gain	Gain accuracy	Output=TBDV <sub>PPDIFF</sub> , 500kHz		-0.4		0.4	dB

**PIN DESCRIPTION**

<b>PIN</b>	<b>PIN NAME</b>	<b>PIN FUNCTION</b>	<b>PIN DESCRIPTION</b>
1	EN_AC	Digital input	A logic high enables the input common-mode feedback loop, and input bias current cancellation circuit
2	GND	Ground	Device Ground
3	INP	Analog input	Positive terminal of differential input
4	INN	Analog input	Negative terminal of differential input
5	GND	Ground	Device Ground
6	G0	Digital input	Least Significant Bit of programmable gain select
7	G1	Digital input	Second Least Significant Bit of programmable gain select
8	G2	Digital input	Third Least Significant Bit of programmable gain select
9	G3	Digital input	Most Significant Bit of programmable gain select
10	NC	No Connect	
11	FAULT	Digital output (open drain)	A logic level high indicates that the device has an output short circuit or that a thermal overload has occurred
12	FORC_BIAS	Digital input	When set to a logic high, the device forces the bias on regardless of fault conditions Intended for test only
13	TH_FAULT	Analog input	When set to a logic high, the device simulates a thermal fault. Intended for test only
14	RESETB	Digital input	When AUTO_CLR is set to a logic low, a logic low pulse on RESETB clears the internal Fault latch; otherwise, connect RESETB to VDD5; Logic low puts device in disabled mode
15	LOPWR	Digital input	When set to logic high, the device goes into low-power mode
16	VSS5	Power supply	Negative 5V supply voltage
17	NC	No Connect	
18	OUTN	Analog output	Negative terminal of differential output
19	NC	No Connect	
20	VSS15	Power supply	Negative 15V supply voltage
21	VDD15	Power supply	Positive 15V supply voltage
22	NC	No Connect	
23	OUTP	Analog output	Positive terminal of differential output
24	NC	No Connect	
25	VDD5	Power supply	Positive 5V supply voltage
26	NC	No Connect	
27	R <sub>EXT</sub>	Analog input	Sets over-current limit
28	GND	Ground	Device Ground
29	FBN	Analog input	Feedback path for synthesized output impedance
30	FBP	Analog input	Feedback path for synthesized output impedance
31	AUTO_CLR	Digital input	A logic high forces an immediate reset of the fault latch when RESETB is a logic high. A logic low requires that the RESETB pin be pulsed low to reset the fault latch
32	NC	No Connect	
EP	Exposed pad	Substrate	Exposed pad at underside of device; must be connected to VSS15. Internally connected to the substrate.

## TLD4012 32-PIN TQFP WITH EXPOSED DIE PAD

(Top View)



## FUNCTIONAL DESCRIPTION

### Programmable Gain

The gain of the TLD4012 is programmed by the digital inputs G3, G2, G1 and G0. The gain given below is the gain from the input to the output of the TLD4012 with  $R_S=10\Omega$  and  $R_{LOAD}=50\Omega$  as shown in Figure 1. Note that output voltage swing is limited for gains less than 17.8 dB (see parameter  $V_{OUTMAX}$  in Electrical Characteristics).

G3	G2	G1	G0	Gain, dB	Gain, V/V
0	0	0	0	12.8	4.37
0	0	0	1	13.8	4.90
0	0	1	0	14.8	5.50
0	0	1	1	15.8	6.17
0	1	0	0	16.8	6.92
0	1	0	1	17.8	7.76
0	1	1	0	18.8	8.71
0	1	1	1	19.8	9.77
1	0	0	0	20.8	10.96
1	0	0	1	21.8	12.30
1	0	1	0	22.8	13.80
1	0	1	1	23.8	15.49
1	1	0	0	24.8	17.38
1	1	0	1	25.8	19.50
1	1	1	0	26.8	21.88
1	1	1	1	27.8	24.55

### Protection Circuits

The TLD4012 has built-in protection against over-temperature and over-current conditions. There are two modes in which the fault protection circuits can operate depending on the state of the AUTO\_CLR pin. The two modes operate as follows:

1. AUTO\_CLR pin is set to a logic low level - When the device goes into an over-temperature or over-current condition, the FAULT pin is latched into a logic HIGH state indicating a fault condition. When this occurs, the amplifier outputs enter disable mode and are in a high-impedance state provided OUTP and OUTN are not driven externally to exceed approximately  $\pm 2.0V_{ppdiff}$ . After the fault condition has been removed, a logic LOW pulse must be applied to the RESETB pin for a minimum of 100 ns to reset the FAULT output to a logic low level, and re-enable the output to a normal, low impedance mode.
2. AUTO\_CLR pin is set to a logic high level - After a fault occurs and the fault condition is removed, the device will enable the outputs, and reset the FAULT pin every 1 micro-second. In this mode the fault latch is reset internally on power up so an external reset is not required. Note that in the case of an over-current fault, if the cause of the over-current condition has not actually cleared, the output stage will cycle continuously between the normal, enabled state, and the fault, or disabled state. In this mode the FAULT output pin can cycle continuously until the cause of the fault is cleared. If this operation is not desirable, see the "Over-current Protection" section below. If a microcontroller or DMT processor is used to monitor the FAULT output, and to control the device, AUTO\_CLR should be set to a logic low level. Otherwise, AUTO\_CLR should be set to a logic high level and the device will reset itself on power-up and after a fault condition has been removed.



### Over-temperature Protection

An over-temperature fault occurs if the junction temperature of the device exceeds approximately 160°C. When a fault occurs the TLD4012 output driver enters the disabled mode, and asserts a logic HIGH on the FAULT pin. An over-temperature fault can only be cleared after the junction temperature drops below approximately 120°C.

### Over-current Protection

An over-current fault occurs when current delivered from either of the output pins, OUP or OUTN, exceeds the current limit value. When a fault occurs, the TLD4012's output driver enters disabled mode, and asserts a logic HIGH on the FAULT pin. The level at which the current limit occurs is set by  $R_{EXT}$ . The relationship between the over-current limit and  $R_{EXT}$  is:

$R_{EXT} = 19.2 / I_{CL}$ , where  $I_{CL}$  is the short circuit current limit in A, and  $R_{EXT}$  is in k $\Omega$ .

The acceptable range of  $R_{EXT}$  is 19.2 k $\Omega$  to 32 k $\Omega$ , or 1.0 A to 600 mA, respectively. A typical value for  $R_{EXT}$  in most ADSL applications is 24k $\Omega$  which results in an 800mA current limit.

If the device is operated with AUTO\_CLR set to a logic high level, and an over-current condition occurs, the device will cycle between the fault state and normal state as described in the "Protection Circuits" section above.

If the cycling mode described above is not desirable, the over-current limit can be set to 1.0 A, (i.e.  $R_{EXT} = 19.2$  k $\Omega$ ). With this current limit value, the device will not enter the cycling mode if a short occurs on the twisted pair because the matching resistors,  $R_S$ , will limit the current to less than 1.0A. The over-temperature protection will eventually act to protect the device, and in the event of a short on the board, the over-current protection will still take affect to protect the device.

### Low-Power Mode

The TLD4012 can be placed into a low-power consumption mode by asserting a logic HIGH on the LOPWR input. In this mode the device consumes approximately 130 mW, but still provides a low output resistance to allow reception of incoming signals.

### Disable Mode

The TLD4012 can be placed in a lower power disabled mode by holding RESETB to a logic low level. In this mode the power dissipation is only 10 mW, and the line is not terminated so reception of incoming signals is not reliable. In this mode the outputs are high impedance as long as they are not driven externally more than about  $\pm 2.0V_{ppdiff}$  around ground. Beyond this voltage the outputs become low impedance.

Upon power-up the TLD4012 does not exit disabled mode until the VDD5/VSS5 power supply pins are greater than about 4.2V. It will automatically enter disabled mode when the VDD5/VSS5 supply pins are less than about 4.0V.

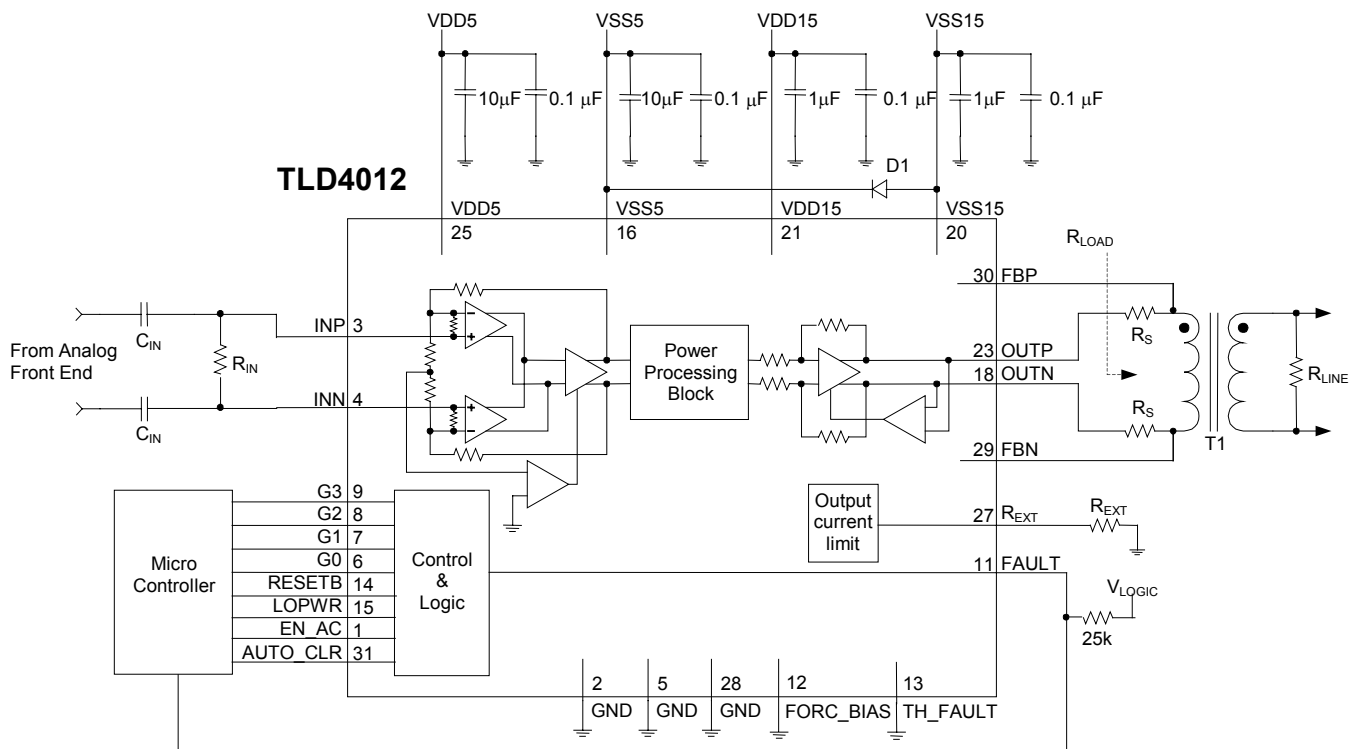
### Input Common-mode Feedback Loop and Input-Bias-Current Cancellation

The TLD4012 has a common-mode feedback loop on the input stage and an input-bias-current cancellation circuit. Setting the EN\_AC input to a logic high level enables both features. When enabled the common-mode feedback loop will set the common-mode input voltage. This allows use of a differential filter (i.e. not referenced to ground) between the AFE and the driver. When the common-mode feedback loop is disabled (EN\_AC = Low) the application should replace the single input resistor,  $R_{IN}$ , shown in Figure 1 with two input resistors connected from the inputs, INN and INP, to ground.

## TEST/APPLICATION CIRCUIT

### Synthesized Output Impedance

Device TLD4012 employs synthesized output impedance with a synthesis factor of 2.55. As with any line driver, using synthesized impedance reduces power consumption, but may compromise receive-signal strength in some applications. The  $10\Omega$  matching resistors will properly terminate a  $100\Omega$  line when a 1:1.4 transformer is used (see Figure 1). Note that, for simplicity, the hybrid and other filtering associated with the receive signal path are not shown.



T1 = 1:1.4 Transformer

$C_{IN} = 0.1 \mu F$

$R_{IN} = 5 k\Omega$

$R_S = 10 \Omega$

$R_{EXT} = 24 k\Omega$

$R_{LINE} = 100 \Omega$

D1 = One UPS840 schottky diode or equivalent per 48 drivers.

Test/Application Circuit – with synthesized output impedance, TLD4012

Figure 1

## APPLICATION INFORMATION

### Power Dissipation Derating for 5x5mm TQFP with Exposed Die Pad

For operating at ambient temperatures above 25°C the device power dissipation,  $P_{DISS}$ , must be de-rated based on a 150°C maximum junction temperature  $T_J(\text{max})$  as given by the following equation:

$$P_{DISS} = (T_J(\text{max}) - T_A) / \theta_{JA}$$

Where  $\theta_{JA}$  of the package is determined from the table, and  $T_A$  is the ambient temperature.

Airflow (LFPM)	$\theta_{JA}$ , C/W (Copper Pad Soldered To PCB)
	5x5mm
0	34.5
200	29.1
500	27.2

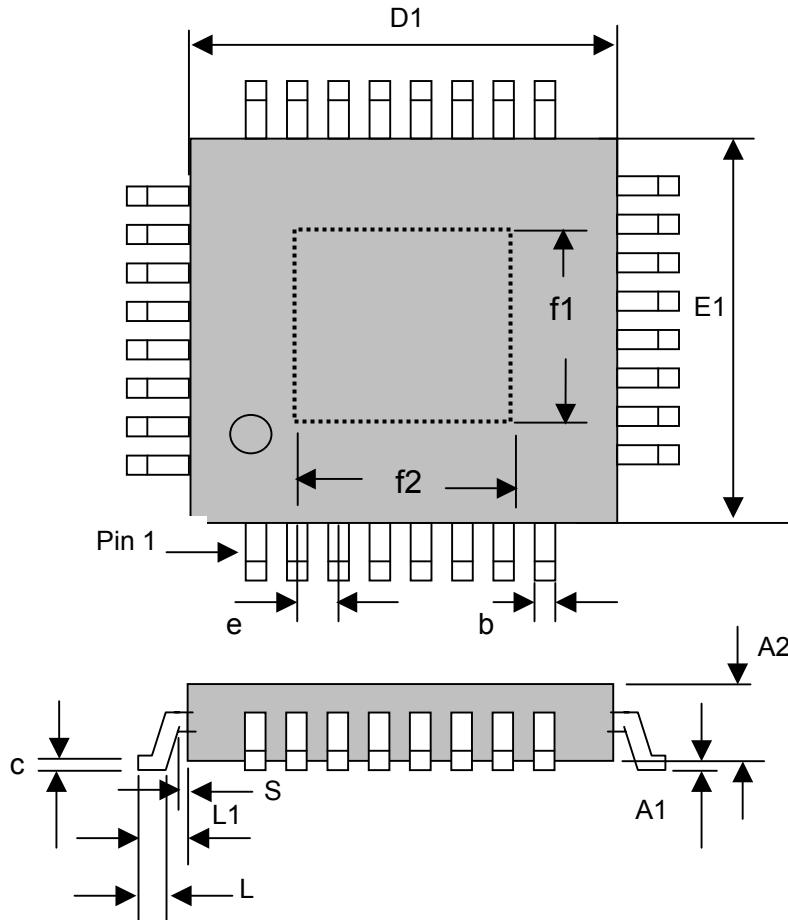
Values apply when the exposed pad is soldered to a JEDEC standard test board.

Note that  $P_{DISS}$  is the power dissipated on the chip, not  $P_{CONS}$  which is the power consumed from the supplies.

The TLD4012 incorporates an exposed die pad on the underside of its package. This acts as a heat sink and should be connected to a copper plane on the printed circuit board for optimum heat dissipation. This copper plane must be connected to VSS15.

**PACKAGE INFORMATION**

**5x5mm TQFP with exposed die pad**



**All dimensions in mm**

BODY SIZE		LEAD COUNT	STANDARD-OFF	BODY THICKENESS	LEAD LENGTH	LEAD WIDTH	LEAD THICKENESS	LEAD PITCH	LEAD BOTTOM ATTACHMENT	LEAD SHOULDER	EXPOSED PAD (BOTTOM SIDE)	
D1	E1										A1	A2
5.0	5.0	32	0.04	1.0	1.0	0.22	0.15	0.5	0.45-0.75	Min0.2	3.5	3.5

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