●新特器件应用

ADSL放大芯片MAX4363的原理及应用

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The Principle and Application of ADSL Amplifier MAX4363

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摘要：MAX436X系列高性能ADSL激励或激励/接收放大器是美国MAXIM公司为宽带上网需求推出的新型ADSL收发放大芯片。文中介绍了MAX4363芯片的封装、结构和引脚功能，给出了MAX4363的典型应用电路以及使用时的注意事项。

关键词：ADSL；　宽带；　放大；　MAX4363

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1　概述

ADSL(非对称数字用户线)技术由于能满足人们宽带上网的需求而在近两年得到了迅速发展。它符合人们对下载速度要求快而对上传速度要求并不高的实际情况。和其它xDSL技术相比，ADSL以其成本较低，在市场上获得了成功。MAX436x系列芯片是高性能的ADSL激励或激励/接收放大器，它采用5V单电源供电。对于DMT(离散多音)调制信号，该芯片可提供12.5dBm的平均线路功率，因而能够满足全速ADSL的需求。

MAX436x系列芯片包括MAX4361、MAX4362和MAX4363。其中MAX4361是具有3.1V/V固定增益(由内部的3个电阻设定)的差分输入/差分输出型激励放大器，而MAX4362和MAX4363的增益可由外部电阻设置，因此它们的增益可变，这两种器件都有用作差分输入/差分输出的Shutdown管脚，其区别在于MAX4362内部有二个放大器，一般用作激励放大器，而MAX4363内部有四个放大器，它们既可用作激励放大器又可同时用作激励/接收放大器。

MAX436x采用节省空间的8脚μMAX封装；MAX4362有μMAX和SO两种封装形式；MAX4363的封装形式为SO/TSSOP。本文重点介绍MAX4363芯片。MAX436x系列芯片的主要特点如下：

●低噪声激励，电压/噪声密度为4.8V/(Hz)$^{1/2}$；电流/噪声密度为1.5pA/(Hz)$^{1/2}$；

●全速率ADSL ATU-R线路激励和接收；

●采用5V单电源供电；

●从激励到接收的串话(MAX4363)为-95dB；

●具有+12.5dBm的平均线路功率(DMT)；

●峰值输出电流最小为280mA；

●具有超温和短路保护功能。

2　结构及引脚功能

MAX4363内部结构及外部引脚图如图1所示。该芯片共有20个引出脚，内含四个放大器，其中两个可用作激励放大器，另两个用作接收放大器。该芯片的收发电源和地各自独立。表1所列是MAX4363的各引脚名称及功能。

MAX4363带有低功率关断模式，当SHDN脚被拉高，且供电电流降到70μA时，放大器输出高阻disable模式。平常则将SHDN接地。

3　应用电路及注意事项

MAX4363的典型应用电路如图2所示。下面对较重要的元器件的作用和选取原则作一些说明。

(1)电源及退耦

为了达到ADSL 12.5dBm的最优上传驱动能力

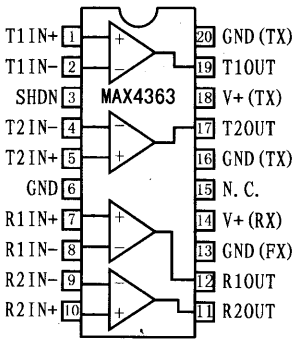

图1　MAX4363芯片引脚图

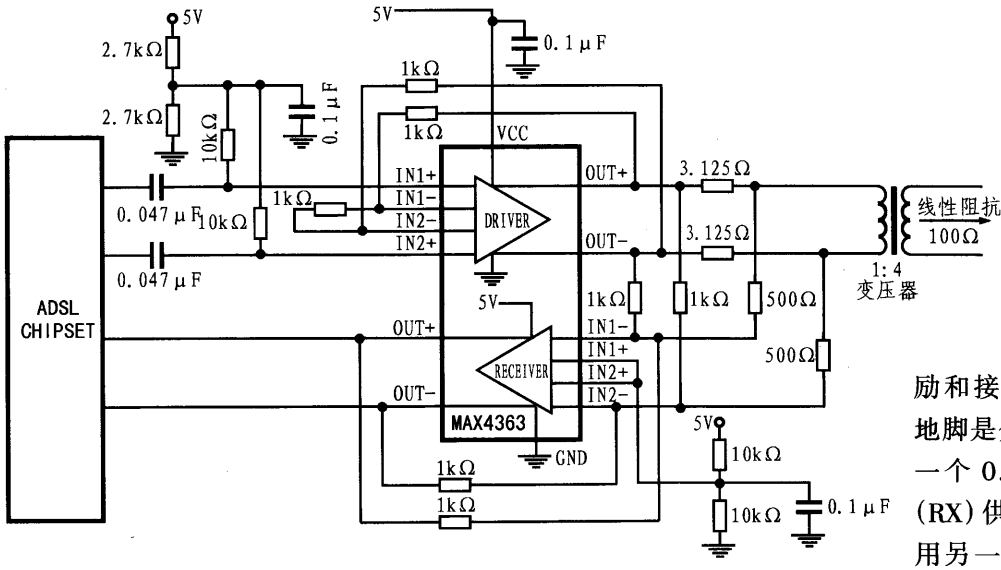

图 2 典型应用电路

及维持最好的动态范围，必须为 MAX4363 提供精心校准的低噪 4.5～5.5V 的电源电压。所以，应采用具有低等效串联电阻的高质量电容（如多层陶瓷电容 MLCC）来滤除电压波纹，以使功耗最小。另外，在邻近 MAX4363 处还要接一个大容量的电容来提高对低频信号的退耦性能。

另外，0.1μF 的 MLCC 退耦电容应尽可能靠近每个电源供电脚，其距离不能超过 1/8 英寸。同时在板上供电电压处，必须用另一个 4.7～10μF 的大容量钽电容来提供电流，以适应芯片输出处信号的快速变化。

由于 MAX4363 激励和接收放大器的供电和接地脚是分开的。因此，应使用一个 0.1μF 电容来旁路 V+(RX) 供电脚和地 (RX) 脚，而用另一个 0.1μF 电容来旁路 V+(TX) 供电脚和地 (TX) 脚，而且，两个电容都应尽可能靠近各自的 IC 引线。

表 1 MAX4363 引脚功能

管脚	名称	功　能
1	T_1IN_+	一激励放大器正相输出
2	T_1IN_-	一激励放大器反相输出
3	SHDN	Shutdown 脚，通常接地
4	T_2IN_+	二激励放大器正相输出
5	T_2IN_-	二激励放大器反相输出
6	GND	地
7	R_1IN_+	一接收放大器正相输入
8	R_1IN_-	一接收放大器反相输入
9	R_2IN_+	二接收放大器正相输入
10	R_2IN_-	二接收放大器反相输入
11	R_2OUT	二接收放大器输出
12	R_1OUT	一接收入大器输出
13	GND(RX)	(接收放大器的)地
14	V_+(RX)	接收放大器正电源。需接 0.1μF 电容旁路 V+(RX)和 GND(RX)
15	N.C.	无外部联接(No connection)
16、20	GND(TX)	(激励放大器的)地
17	T_2OUT	二激励放大器输出
18	V_+(TX)	激励放大器正电源，需接 0.1μF 电容旁路 V+(TX)和 GND(TX)
19	T_1OUT	一激励放大器输出

(2)USB 应用

对 USB 串口，5V 供电很难满足 ADSL 调制解调器所需要的峰值电流。只有提高供电质量，才能优化用 USB 供电的 ADSL 调制解调器中 MAX4363 的性能。采用升压 DC－DC 转换器可以解决此问题。但必须注意 DC－DC 转换器输出处的电源退耦及 MAX4363 供电脚的退耦。

(3)驱动电容性负载

MAX4363 驱动电容性负载的能力为 2nF。为了增加电容驱动能力，可在输出和负载间接一个隔离电阻以减少输出信号的影响。如图 3 所示，在一个典型的桥接网络中，反向匹配电阻在大多数电容性负载情况下可提供充分的隔离效果。

(4)功耗

为了确定应用中热耗的范围，考虑 MAX4363 的整个功耗是十分重要的。通过一些简单的假设条件可以估计出激励中的整个功耗（见图 2）。如果输出电流和静态电流相比很大，那么，计算出输出设备的功耗和静态功耗之和，就可以对整个功耗作出近似的估计。

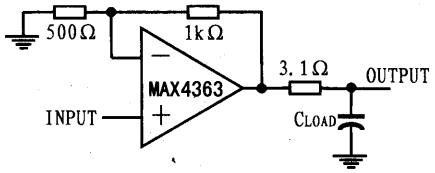

图 3 驱动电容性负载示意图

在100Ω线路上，平均线路功率为12.5dBm，RMS电流为13.4mA。如果用一个1:4的变压器，其激励放大器就可提供53.6mA的RSM电流。对DMT信号，RMS电流变为平均检波电流的比率是0.8。整个功耗大约为：

$P_{CONS} = 0.8 \times 53.6 \times 5 = 214mW$

其中18mW为线路功耗，消耗在反向匹配电阻中。这样，平均消耗在IC上的功耗大约为178mW加上静态功耗110mW，因此，其总功耗约为288mW。这对于8脚μMAX封装的MAX4361来说，相当于温度上升64℃，加上环境温度85℃，总共是148℃，低于绝对最大温度值150℃。

应当说明的是：MAX4363的最大RMS电流是200mA。超过200mA将导致热断开。

(5)变压器(Transformer)的选择

通常符合用户要求的全速ADSL要传送12.5dBm(18mW)的DMT信号。DMT信号的典型波峰因子为5.3，这就要求线路放大器提供的峰值线路功率为27.5dBm(560mW)。在100Ω电话线上，这相当于28.4V的峰值差分电压。在5V供电且低失真时，MAX4363线路放大器可提供的最大输出漂移为3.8V。考虑到反向匹配电阻引起的功率损失，升压变压器的变匝比至少应为3.8。在图2中，MAX4363通过一个变匝比为1：4的升压变压器和电话线耦合。R1和R2是反向匹配电阻，阻值为3.1Ω(可通过$100/(2\times4^2)$近似计算，其中100Ω是电话线的近似阻抗，包括终端电阻)。MAX4363的整个差分负载为12.5Ω。

(6)接收信道的考虑

激励放大器在差分线路输出时，可采用变压器把线路上的差分输出电压升高，这对从线路上接收的信号具有相反的影响。其典型的桥接电路的接收信道的电压以相反的变匝比减少。接收电路对在噪声中的低电平信号的检测能力也限制了变压器的变匝比。高变匝比的变压器由于减少了接收信号的强度，从而可减少接收信噪比。

MAX4363内部带有一个典型电压/噪声比仅为8.5nV/$\sqrt{Hz}$的放大器和用作接收信道的低电流(2mA)供给放大器。

(7)电路图布线

好的布线技术可以减少放大器输入输出的分布电容，从而优化性能，而过多的电容会在放大器的频率响应上产生尖峰。为减少分布电容，应把外部元件尽可能靠近放大器以减少布线长度。

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MAXIM

ADSL Drivers/Receivers for Customer Premise Equipment

General Description

The MAX4361/MAX4362/MAX4363 are a family of high-performance ADSL drivers and drivers/receivers ideal for the upstream transmit path and the downstream receive path of customer premise equipment. These devices operate from a single 5V supply and deliver up to 12.5dBm average line power for DMT modulated signals, meeting the requirements of full-rate ADSL. Spurious-free dynamic range (SFDR) at full output power is typically -75dBC at 100kHz.

The MAX4361 is a differential IN/differential OUT driver with a fixed gain of 3.1V/V. The MAX4362 is a dual amplifier with shutdown intended for use as a differential IN/differential OUT driver with gain set with external resistors. The MAX4363 is a quad amplifier with shutdown intended for use as a differential IN/differential OUT driver/receiver combination with gain set with external resistors.

The MAX4361 is offered in a space-saving 8-pin µMAX package.

Applications

ADSL Line Interface

HDSL Line Driver

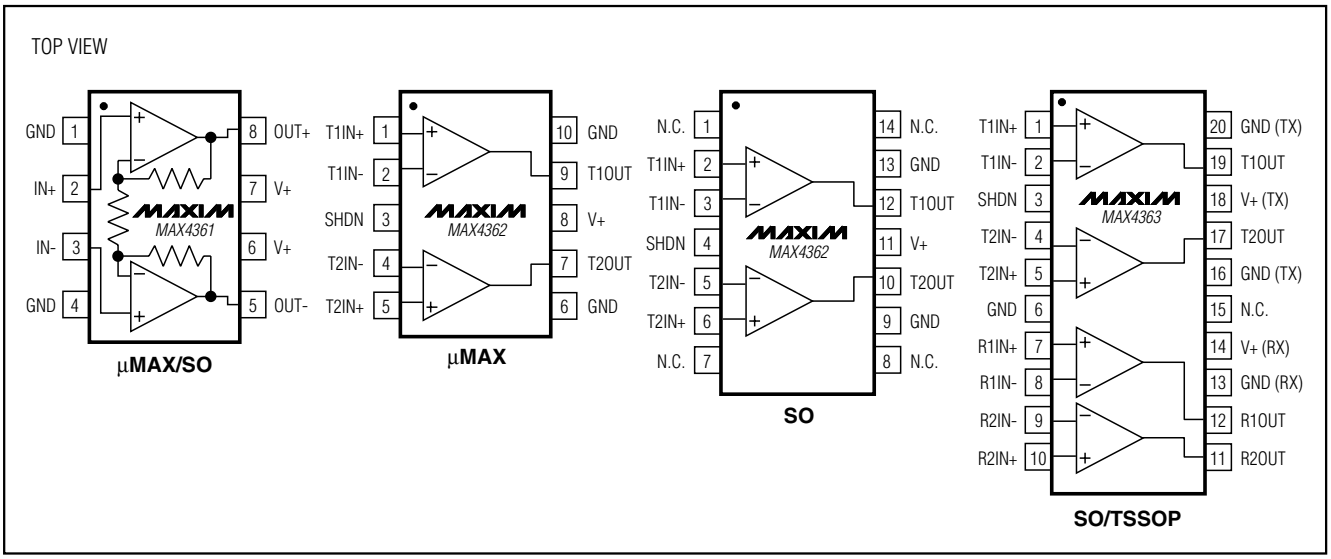
Features

- ♦ **Low-Noise Driver**
  4.8nV/√Hz Voltage-Noise Density
  1.5pA/√Hz Current-Noise Density
- ♦ **Full-Rate ADSL ATU-R Line Drivers and Receivers**
- ♦ **Single 5V Supply**
- ♦ **-75dBc SFDR at Full Output Power at 100kHz**
- ♦ **-95dB Driver-to-Receiver Crosstalk (MAX4363)**
- ♦ **+12.5dBm Average Line Power (DMT)**
- ♦ **280mA (min) Peak Output Current**
- ♦ **Rail-to-Rail® Output Swing**
- ♦ **Thermal and Short-Circuit Protection**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX4361EUA	-40°C to +85°C	8 µMAX
MAX4361ESA	-40°C to +85°C	8 SO
MAX4362EUB	-40°C to +85°C	10 µMAX
MAX4362ESD	-40°C to +85°C	14 SO
MAX4363EUP	-40°C to +85°C	20 TSSOP
MAX4363ESP	-40°C to +85°C	20 SO

Pin Configurations



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ADSL Drivers/Receivers for Customer Premise Equipment

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V+ to GND) .....-0.3V to +6V
Analog Input Voltage .....(GND - 0.3V) to (V+ + 0.3V)
SHDN Input Voltage.....(GND - 0.3V) to (V+ + 0.3V)
Output Short-Circuit Duration 10s
Driver Output Current.....1A
Receiver Output Current.....150mA
Continuous Power Dissipation (T_A = +70°C)
8-Pin µMAX (derate 4.5mW/°C above +70°C) 362mW
10-Pin µMAX (derate 5.6mW/°C above +70°C) 444mW
8-Pin SO (derate 5.88mW/°C above +70°C).....471mW
14-Pin SO (derate 8.33mW/°C above +70°C).....667mW
20-Pin SO (derate 10.0mW/°C above +70°C).....800mW
20-Pin TSSOP (derate 10.9mW/°C above +70°C) 879mW
Operating Temperature Range .....-40°C to +85°C
Junction Temperature.....+150°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—Driver

(V+ = 5V, GND = 0, V_{CM} = 2.5V, R_L = 12.5Ω, SHDN = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values specified at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage Range (Note 1)	V_{CC}			4.5		5.5	V
Supply Current	I_Q	MAX4361, R_L = ∞			22	33	mA
		MAX4362, R_L = ∞	SHDN = 0		22	33	mA
			SHDN = 5V		60	200	µA
		MAX4363, measured at V+ (TX), R_L = ∞	SHDN = 0		22	33	mA
			SHDN = 5V		60	200	µA
		MAX4363, measured at V+ (RX), R_L = ∞	SHDN = 0		4	6.5	mA
			SHDN = 5V		70	200	µA
Maximum Average Output Power (Notes 2, 3)	P_{OUT}	DMT modulation		15.5			dBm
		CAP modulation		18			
Gain	G	MAX4361 (0.7V ≤ V_{OUT} ≤ (V+) - 0.7V)		3.0	3.1	3.2	V/V
Open-Loop Gain	A_{VOL}	MAX4362/MAX4363 (0.7V ≤ V_{OUT} ≤ (V+) - 0.7V)		68	81		dB
Second Harmonic Distortion (Notes 3, 4)		G = 3.1, f = 100kHz, $V_{OUT(DIFF)}$ = 7.1V_{P-P}		-66	-76		dBc
Third Harmonic Distortion (Notes 3, 4)		G = 3.1, f = 100kHz, $V_{OUT(DIFF)}$ = 7.1V_{P-P}		-68	-79		dBc
Peak Output Current	I_{OUT}	Inferred from Output Voltage Swing test		280	330		mA
Input Offset Voltage	V_{OS}				±0.5	±10	mV
Input Bias Current	I_B				1.6	4.5	µA
Input Offset Current	I_{OS}	MAX4361			±30	±600	nA
		MAX4362/MAX4363			±10	±500	
Differential Input Resistance	$R_{IN(DIFF)}$	MAX4361			25		MΩ
		MAX4362/MAX4363			40		kΩ

ELECTRICAL CHARACTERISTICS—Driver (continued)

(V+ = 5V, GND = 0, V_{CM} = 2.5V, R_L = 12.5Ω, SHDN = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values specified at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Common-Mode Voltage Range	V_{CM}	Inferred from CMRR test		1.25		4.50	V
Common-Mode Rejection Ratio	CMRR	1.25V ≤ V_{CM} ≤ 4.5V	MAX4361	60	73		dB
			MAX4362/MAX4363	70	85		
Power-Supply Rejection Ratio	PSRR	V+ = 4.5V to 5.5V	MAX4361	60	89		dB
			MAX4362/MAX4363	60	74		
AC Power-Supply Rejection Ratio	$PSRR_{AC}$	f = 100kHz	MAX4361		63		dB
			MAX4362/MAX4363		49		
Differential Output-Voltage Swing (Note 4)	$V_{OUT(DIFF)}$	Inferred from Output Voltage Swing test		7.4	8.2		V_{P-P}
Output-Voltage Swing (Note 4)	V_{OH}, V_{OL}	R_L = 100Ω	(V+) - V_{OH}		215	550	mV
			V_{OL}		230	550	
		MAX4362/MAX4363 R_L = 12.5Ω	(V+) - V_{OH}		400	600	
			V_{OL}		430	650	
		MAX4361, R_L = 12.5Ω, T_A = -20°C to 85°C	(V+) - V_{OH}		400	600	
			V_{OL}		430	650	
Output Short-Circuit Current	I_{SC}				±650		mA
Output Resistance	R_{OUT}	MAX4361			0.3		Ω
		MAX4362/MAX4363, G = 1			0.001		
SHDN Logic Low	V_{IL}					0.8	V
SHDN Logic High	V_{IH}			2.0			V
SHDN Input Current	I_{IH}, I_{IL}	SHDN = 0 or SHDN = V+				±10	µA
Shutdown Output Impedance	$Z_{OUT(SD)}$	f = 1MHz			1.8		kΩ
-3dB Bandwidth	BW	MAX4361			40		MHz
		MAX4362/MAX4363, G = 1			60		
Slew Rate	SR	$V_{OUT(DIFF)}$ = 7.1V_{P-P} step			30		V/µs
Settling Time (1%)	t_S	$V_{OUT(DIFF)}$ = 7.1V_{P-P} step	MAX4361		115		ns
			MAX4362/MAX4363, G = 3		165		
Voltage-Noise Density	e_n	f = 100kHz to 1.1MHz			4.8		nV/√Hz
Current-Noise Density	i_n	f = 100kHz to 1.1MHz			1.5		pA/√Hz
Capacitive-Load Stability					10		nF
Shutdown Delay Time	t_{SHDN}				400		ns
Enable Delay Time	t_{ENABLE}				2.8		µs

ELECTRICAL CHARACTERISTICS—Receiver (MAX4363 only)

(V+ = 5V, GND = 0, V_{CM} = 2.5V, R_L = ∞, SHDN = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values specified at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Spurious-Free Dynamic Range	SFDR	G = 1, f = 1MHz, V_{OUT} = $1V_{P-P}$			-75		dBc
Gain-Bandwidth Product	GBW				190		MHz
Open-Loop Gain	A_{VOL}	1.5V ≤ V_{OUT} ≤ 3.5V		65	77		dB
Peak Output Current	I_{OUT}	R_L = 50Ω, inferred from Output-Voltage Swing test		18	25		mA
Input Offset Voltage	V_{OS}				±0.5	±10	mV
Input Bias Current	I_B				-0.75	-2	µA
Input Offset Current	I_{OS}				±20	±250	nA
Input Capacitance	C_{IN}				1.6		pF
Differential Input Resistance	$R_{IN(DIFF)}$				76		kΩ
Input Common-Mode Voltage Range	V_{CM}	Inferred from CMRR test		0.25		3.80	V
Common-Mode Rejection Ratio	C_{MRR}	0.25V ≤ V_{CM} ≤ 3.8V		70	87		dB
Power-Supply Rejection Ratio	PSRR	V+ = 4.5V to 5.5V		60	75		dB
AC Power-Supply Rejection Ratio	$PSRR_{AC}$	f = 1MHz			47		dB
Output-Voltage Swing	V_{OH}, V_{OL}	R_L = ∞	(V+) - V_{OH}		0.64	1	V
			V_{OL}		0.73	1	
		R_L = 50Ω	(V+) - V_{OH}		1.27	1.5	
			V_{OL}		1.37	1.6	
Output Short-Circuit Current	I_{SC}				±130		mA
Output Resistance	R_{OUT}	G = 1			0.001		Ω
Slew Rate	SR	V_{OUT} = $1V_{P-P}$ step			160		V/µs
Settling Time (1%)	t_S	V_{OUT} = $100mV_{P-P}$ step, G = 1			40		ns
Voltage-Noise Density	e_n	f = 1MHz			8.5		$nV/\sqrt{Hz}$
Current-Noise Density	i_n	f = 1MHz			0.5		$pA/\sqrt{Hz}$
Driver-Receiver Crosstalk	X_{TALK}	f = 100kHz			95		dB

Note 1: Guaranteed by the Power-Supply Rejection Ratio (PSRR) test.

Note 2: Implied by worst-case output-voltage swing ($V_{OUT(DIFF)}$), crest factor (C_r) and load resistance (R_L):
P_{Driver} = 10log((250 × ($V_{OUT(DIFF)}$)^2 / ((C_r)^2 × R_L)) dBmW

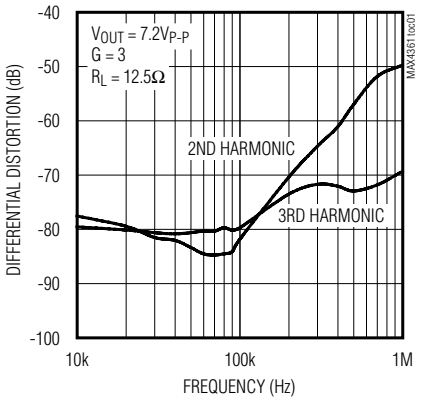
Note 3: Guaranteed by design.

Note 4: May exceed absolute maximum ratings for power dissipation if unit is subject to full-scale sinusoids for long periods (see *Applications Information* section).

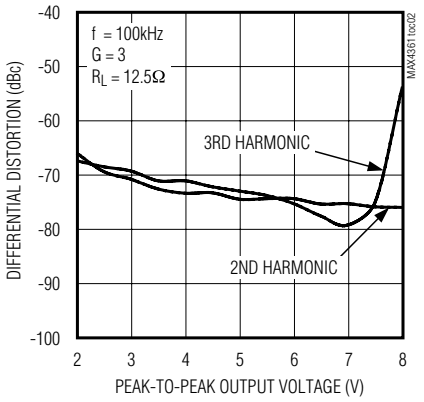
Typical Operating Characteristics

(V+ = 5V, GND = 0, V_{CM} = 2.5V, R_L = 12.5Ω, SHDN = 0, T_A = +25°C.)

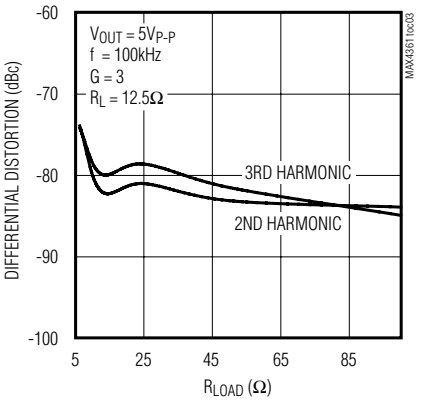
DRIVER DIFFERENTIAL DISTORTION vs. FREQUENCY



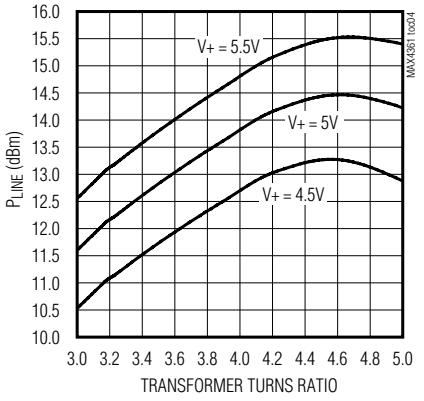
DRIVER DIFFERENTIAL DISTORTION vs. PEAK-TO-PEAK OUTPUT VOLTAGE



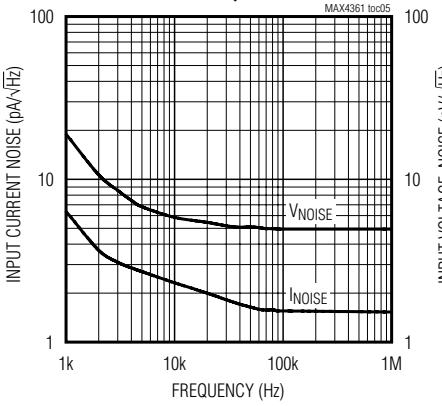
DRIVER DIFFERENTIAL DISTORTION vs. LOAD RESISTANCE



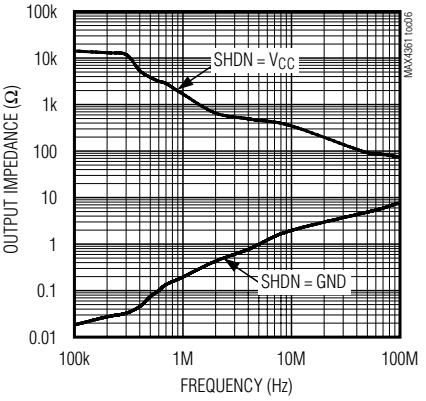
DRIVER LINE POWER vs. TURNS RATIO



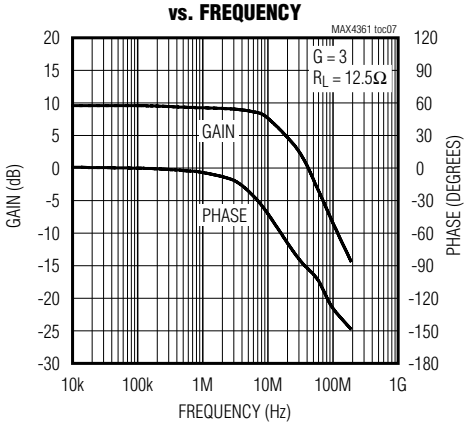
DRIVER CURRENT AND VOLTAGE NOISE vs. FREQUENCY



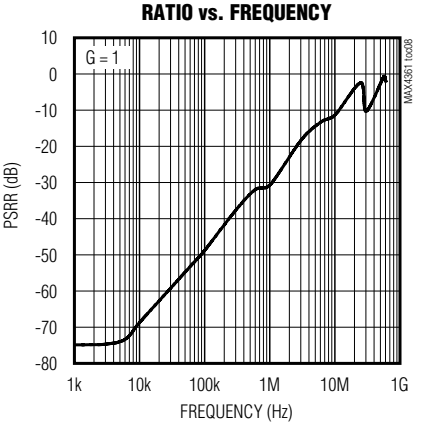
DRIVER OUTPUT IMPEDANCE vs. FREQUENCY



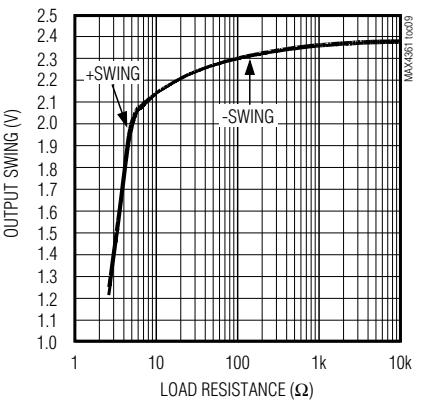
DRIVER GAIN AND PHASE vs. FREQUENCY



DRIVER POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



DRIVER OUTPUT SWING vs. LOAD RESISTANCE

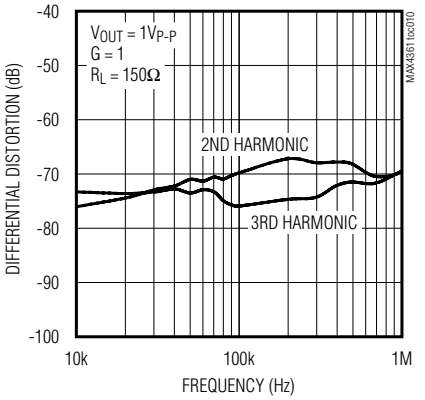


ADSL Drivers/Receivers for Customer Premise Equipment

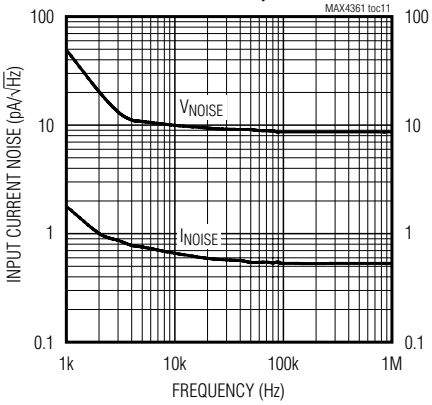
Typical Operating Characteristics (continued)

(V+ = 5V, GND = 0, V_{CM} = 2.5V, R_L = 12.5Ω, SHDN = 0, T_A = +25°C.)

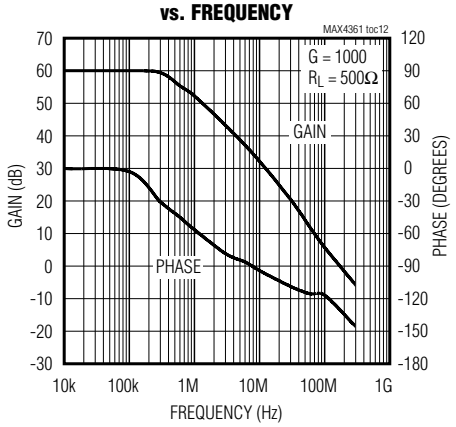
RECEIVER DIFFERENTIAL DISTORTION vs. FREQUENCY



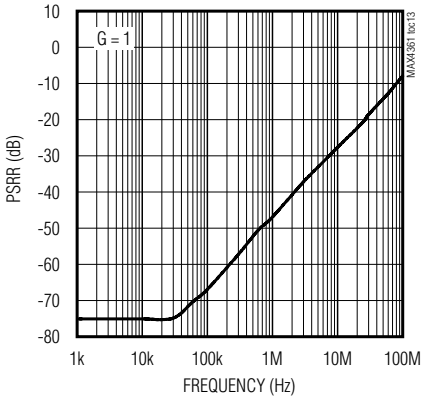
RECEIVER CURRENT AND VOLTAGE NOISE vs. FREQUENCY



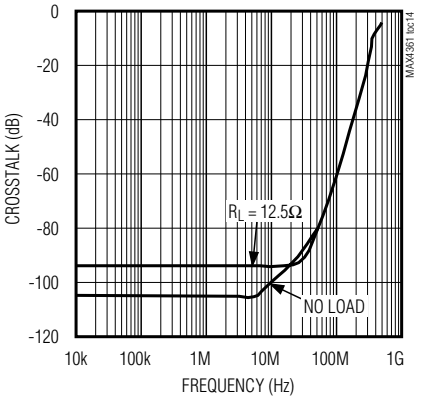
RECEIVER GAIN AND PHASE vs. FREQUENCY



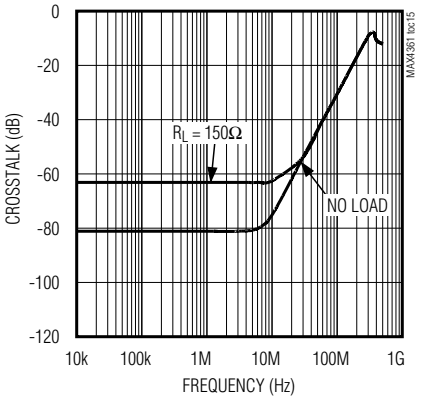
RECEIVER POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



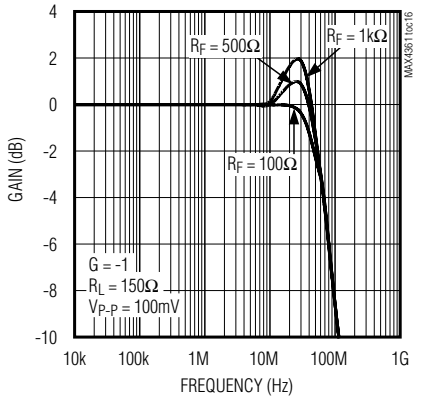
DRIVER-TO-RECEIVER CROSSTALK vs. FREQUENCY



RECEIVER-TO-RECEIVER CROSSTALK vs. FREQUENCY



RECEIVER OUTPUT AMPLITUDE vs. FREQUENCY



Pin Descriptions

MAX4361

PIN	NAME	FUNCTION
1, 4	GND	Ground
2	IN+	First Driver Input
3	IN-	Second Driver Input
5	OUT-	Second Driver Output
6, 7	V+	Positive Power-Supply Voltage. Bypass V+ to GND with a 0.1µF capacitor.
8	OUT+	First Driver Output

MAX4362

PIN		NAME	FUNCTION
µMAX	SO		
1	2	T1IN+	First Driver Noninverting Input
2	3	T1IN-	First Driver Inverting Input
3	4	SHDN	Shutdown. Connect to GND for normal operation.
4	5	T2IN-	Second Driver Inverting Input
5	6	T2IN+	Second Driver Noninverting Input
6, 10	9, 13	GND	Ground
7	10	T2OUT	Second Driver Output
8	11	V+	Positive Power-Supply Voltage. Bypass V+ to GND with a 0.1µF capacitor.
9	12	T1OUT	First Driver Output
—	1, 7, 8, 14	N.C.	No Connection. Not internally connected.

ADSL Drivers/Receivers for Customer Premise Equipment

Pin Descriptions (continued)

MAX4363

PIN	NAME	FUNCTION
1	T1IN+	First Driver Noninverting Input
2	T1IN-	First Driver Inverting Input
3	SHDN	Shutdown. Connect to GND for normal operation.
4	T2IN-	Second Driver Inverting Input
5	T2IN+	Second Driver Noninverting Input
6	GND	Ground
7	R1IN+	First Receiver Noninverting Input
8	R1IN-	First Receiver Inverting Input
9	R2IN-	Second Receiver Inverting Input
10	R2IN+	Second Receiver Noninverting Input
11	R2OUT	Second Receiver Output
12	R1OUT	First Receiver Output
13	GND (RX)	Ground for Receiver Amplifiers
14	V+ (RX)	Positive Power-Supply Voltage for Receiver Amplifiers. Bypass V+ (RX) to GND (RX) with a separate 0.1µF capacitor.
15	N.C.	No Connection. Not internally connected.
16, 20	GND (TX)	Ground for Driver Amplifier
17	T2OUT	Second Driver Output
18	V+ (TX)	Positive Power-Supply Voltage for Driver Amplifiers. Bypass V+ (TX) to GND (TX) with a separate 0.1µF capacitor.
19	T1OUT	First Driver Output

Detailed Description

The MAX4361/MAX4362/MAX4363 are a family of high-performance ADSL drivers and drivers/receivers ideal for the upstream transmit path and the downstream receive path of customer premise equipment. These devices operate from a single 5V supply and deliver up to 12.5dBm average line power for DMT modulated signals, meeting the requirements of full-rate ADSL. SFDR at full output power is typically -75dBc at 100kHz.

Differential In/Differential Out ADSL Driver (MAX4361)

The MAX4361 is a differential line driver with a fixed gain of 3.1V/V. The gain is set by three internal resistors.

Uncommitted Dual Amplifier for ADSL Driver (MAX4362)

The MAX4362 is a dual amplifier with shutdown intended for use as a differential IN/differential OUT driver with gain set with external resistors

Uncommitted Quad Amplifier for ADSL Driver/Receiver (MAX4363)

The MAX4363 is a quad amplifier with shutdown intended for use as a differential IN/differential OUT driver/receiver combination with gain set with external resistors.

Shutdown

The MAX4362/MAX4363 feature a low-power shutdown mode. When the SHDN pin is pulled high, the supply current drops to 70µA, and the amplifier's outputs are placed in a high-impedance disable mode. Connect SHDN to GND for normal operation.

Applications Information

Power Supply and Decoupling

The MAX4361/MAX4362/MAX4363 should be powered from a well-regulated, low-noise, 4.5V to 5.5V supply in order to optimize the ADSL upstream drive capability to +12.5dBm and maintain the best SFDR.

High-quality capacitors with low equivalent series resistance (ESR) such as multilayer ceramic capacitors (MLCCs) should be used to minimize supply voltage ripple and power dissipation. A larger capacitor located in proximity to the MAX4361/MAX4362/MAX4363 improves decoupling for lower frequency signals.

In addition, 0.1µF MLCC decoupling capacitors should be located as close as possible to each of the power-supply pins, no more than 1/8 inch away. An additional large (4.7µF to 10µF) tantalum capacitor should be placed on the board near the supply terminals to supply current for fast, large-signal changes at the MAX4361/MAX4362/MAX4363 outputs.

MAX4361/MAX4362

The MAX4361/MAX4362 require a single 0.1µF bypass from V+ to ground located as close as possible to the IC leads.

MAX4363

The MAX4363 features separate supply and ground pins for the receiver and driver amplifiers. Bypass the V+ (RX) supply to the GND (RX) pin with a 0.1µF capacitor. Bypass the V+ (TX) supply to the GND (TX) pin with a separate 0.1µF capacitor. Both capacitors should be placed as close as possible to their respective IC leads.

USB Applications

The 5V supplied at the universal serial bus (USB) port may be poorly regulated or unable to supply the peak currents required by an ADSL modem. Improving the quality of the supply will optimize the performance of the MAX4361/MAX4362/MAX4363 in a USB-supplied CPE ADSL modem. This can be accomplished through the use of a step-up DC-to-DC converter or switching power supply followed by a low-dropout (LDO) regulator. Careful attention must be paid to decoupling the power supply at the output of the DC-to-DC converter, the output of the LDO regulator and the supply pins of the MAX4361/MAX4362/MAX4363.

Driving a Capacitive Load

The MAX4361/MAX4362/MAX4363 are capable of driving capacitive loads up to 2nF. Most hybrid circuits are well under this limit. For additional capacitive-drive capability use isolation resistors between the output and the load to reduce ringing on the output signal. In a typical hybrid the back-matching resistors provide sufficient isolation for most any capacitive-loading condition (see Figure 1).

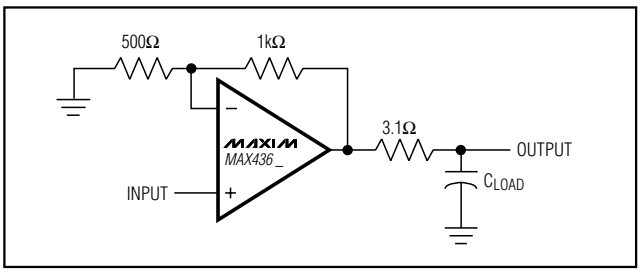


Figure 1. Driving Capacitive Load

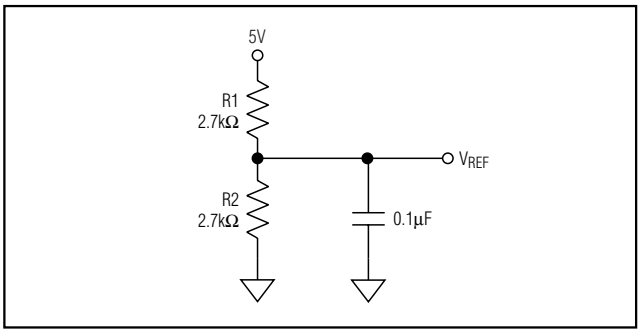


Figure 2. Voltage-Divider Reference

Method for Generating a Midsupply Voltage

To operate an amplifier on a single-voltage supply, a voltage midway between the supply and ground must be generated to properly bias the inputs and the outputs.

A voltage divider can be created with two equal-value resistors (Figure 2). There is a trade-off between the power consumed by the divider and the voltage drop across these resistors due to the positive input bias currents. Selecting 2.7kΩ for R1 and R2 will create a voltage divider that draws less than 1mA from a 5V supply. Use a decoupling capacitor (0.1µF) at the node where V_{REF} is generated.

Power Dissipation

It is important to consider the total power dissipation of the MAX4361/MAX4362/MAX4363 in order to properly size the heat sink area of an application. With some simplifying assumptions we can estimate the total power dissipated in the driver (see *Typical Operating*

ADSL Drivers/Receivers for Customer Premise Equipment

Circuit). If the output current is large compared to the quiescent current, computing the dissipation in the output devices and adding it to the quiescent power dissipation will give a close approximation of the total power dissipation in the package.

For a 12.5dBm average line power on a 100Ω line, the RMS current is 13.4mA. With a one-to-four transformer the driver therefore supplies 53.6mA RMS. It can be shown for a DMT signal the ratio of RMS current to the average rectified current is 0.8. The total power consumption is approximately

$$P_{CONS} = 0.8 \times 53.6 \times 5V = 214mW$$

of which 18mW is delivered as line power and 18mW is dissipated in the back-matching resistors. Hence the average power consumption of the IC is approximately 178mW + quiescent power (110mW), or 288mW. For the MAX4361 in an 8-pin µMAX package, this corresponds to a temperature rise of 64°C. With an ambient temperature of +85°C this corresponds to a junction temperature of +148°C, just below the absolute maximum of +150°C.

Please note the part is capable of over 200mA RMS, which could cause thermal shutdown in applications with elevated ambient temperatures and/or signals with low crest factors. See Figure 3 for a guide to power derating for each of the MAX4361/MAX4362/MAX4363 packages.

Transformer Selection

Full-rate, customer premise ADSL requires the transmission of a +12.5dBm (18mW) DMT signal. The DMT signal has a typical crest factor of 5.3, requiring the line driver to provide peak line power of 27.5dBm (560mW). The 27.5dBm peak line power translates into a 28.4V peak-to-peak differential voltage on the 100Ω telephone line. The maximum low-distortion output swing available from the MAX4361/MAX4362/MAX4363 line driver on a 5V supply is 3.8V and, taking into account the power lost due to the back-matching resistance, a step-up transformer with turns ratio of 3.8 or greater is needed. In the *Typical Operating Circuit*, the MAX4363 is coupled to the phone line through a step-up transformer with a 1:4 turns ratio. R1 and R2 are back-matching resistors, each 3.1Ω (100Ω / (2 × 4^2)), where 100Ω is the approximate phone-line impedance. The total differential load for the MAX4361/MAX4362/MAX4363, including the termination resistors, is therefore 12.5Ω. Even under these conditions the MAX4361/MAX4362/MAX4363 provide low distortion signals to within 0.6V of the power rails.

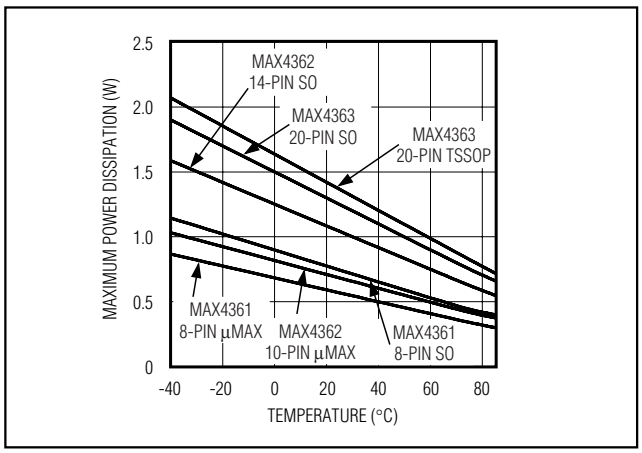


Figure 3. Maximum Power Dissipation vs. Temperature

Receive Channel Considerations

A transformer used at the output of the differential line driver to step up the differential output voltage to the line has the inverse effect on signals received from the line. A voltage reduction or attenuation equal to the inverse of the turns ratio is realized in the receive channel of a typical bridge hybrid. The turns ratio of the transformer may also be dictated by the ability of the receive circuitry to resolve low-level signals in the noisy, twisted-pair telephone plant. Higher turns-ratio transformers effectively reduce the received signal-to-noise ratio due to the reduction in the received signal strength.

The MAX4363 includes an amplifier with typical voltage noise of only 8.5nV/√Hz and a low-supply current of 2mA/amplifier to be used as the receive channel.

Layout Considerations

Good layout techniques optimize performance by decreasing the amount of stray capacitance at the amplifier's inputs and outputs. Excess capacitance will produce peaking in the amplifier's frequency response. To decrease stray capacitance, minimize trace lengths by placing external components as close to the amplifier as possible.

Chip Information

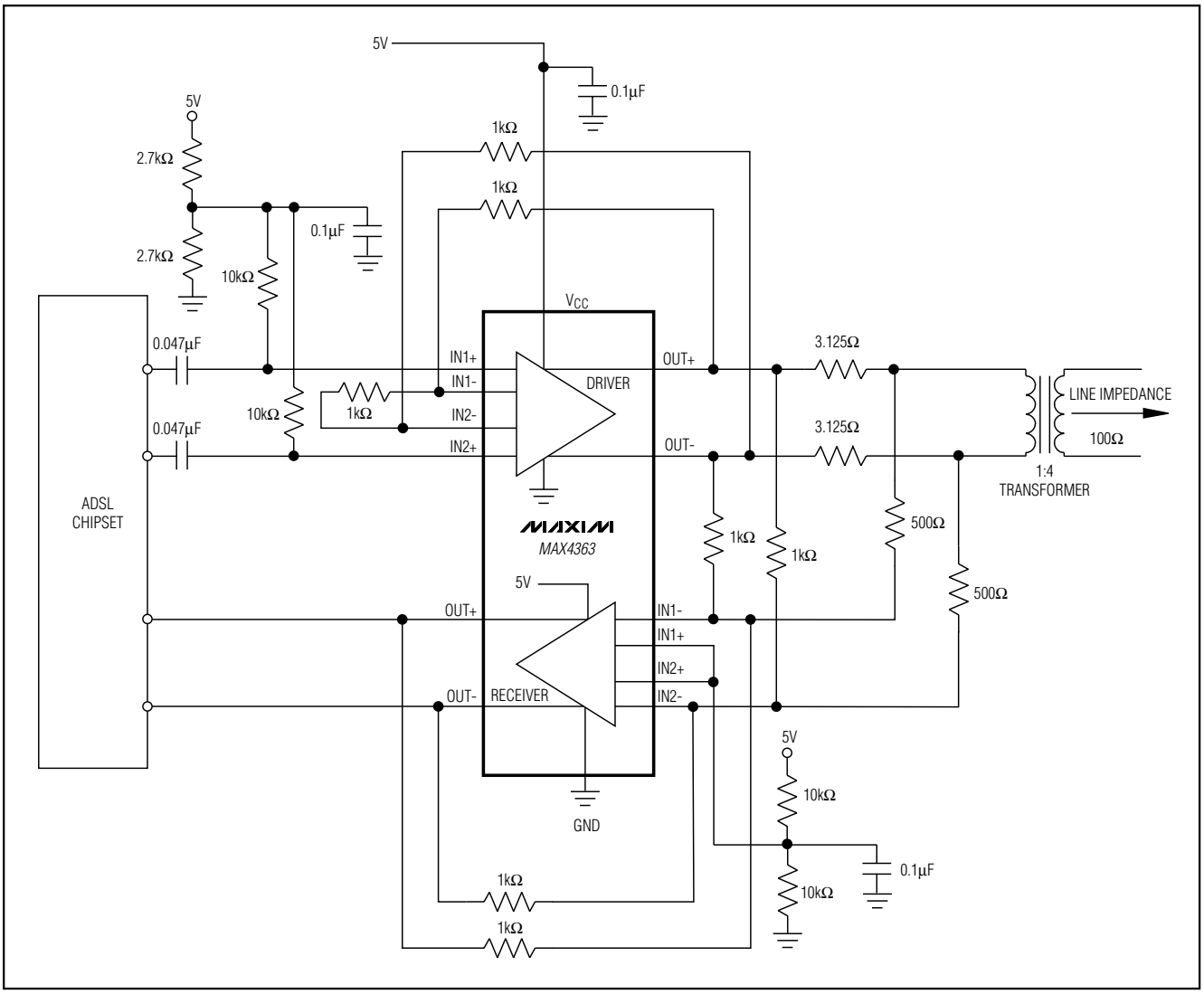
MAX4361 TRANSISTOR COUNT: 1400

MAX4362 TRANSISTOR COUNT: 1400

MAX4363 TRANSISTOR COUNT: 1750

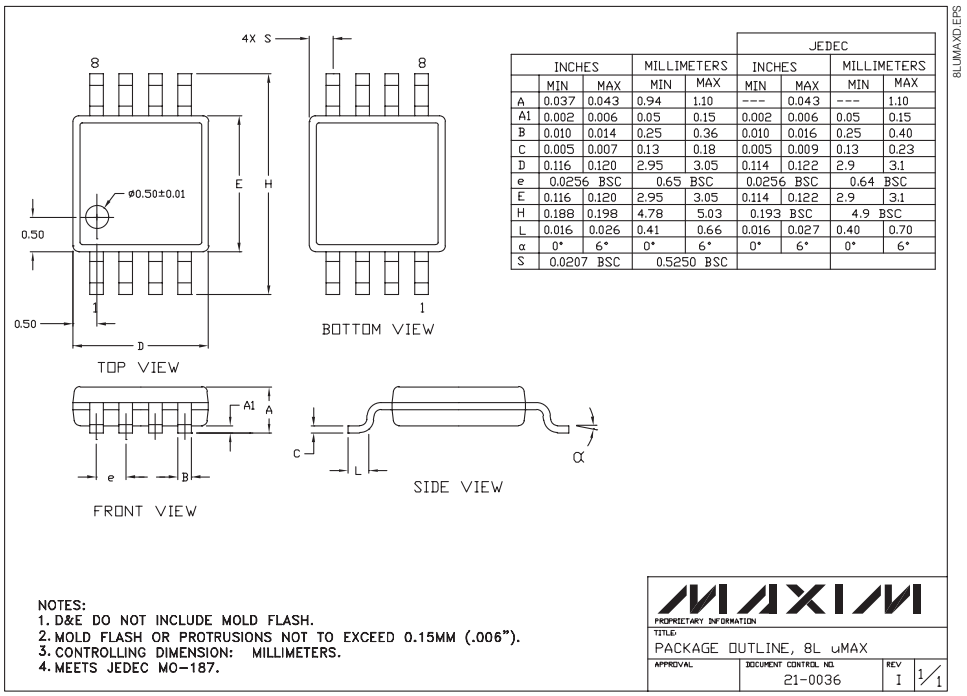
PROCESS: Bipolar

Typical Operating Circuit

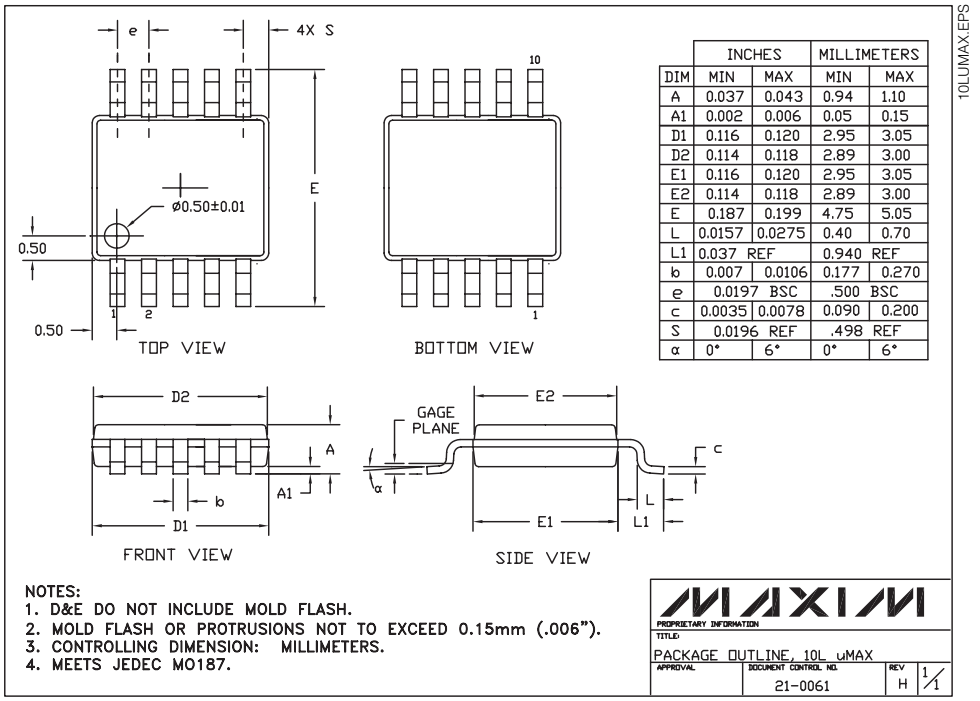


ADSL Drivers/Receivers for Customer Premise Equipment

Package Information

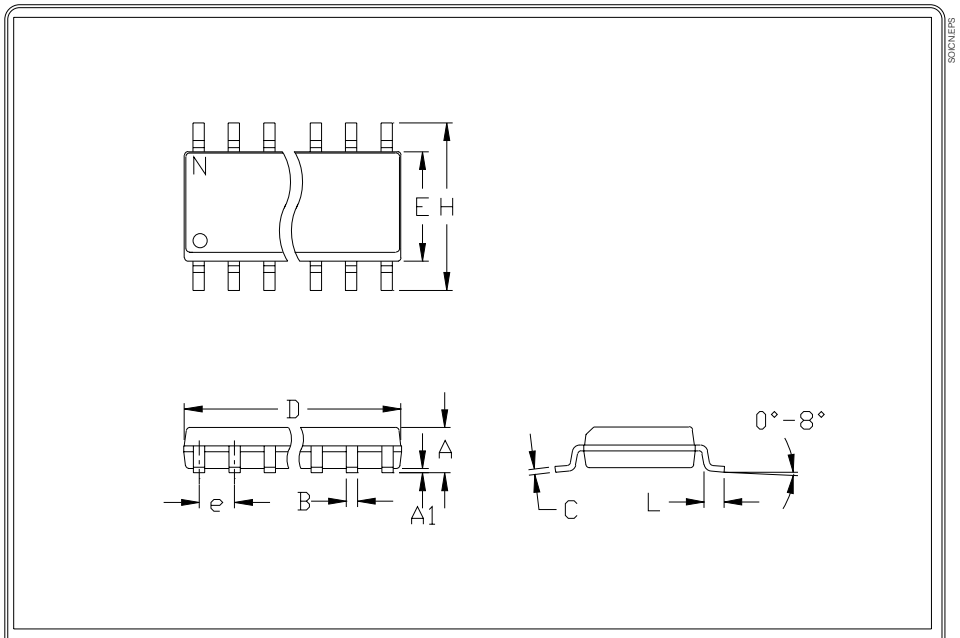


	INCHES		MILLIMETERS		JEDEC INCHES		JEDEC MILLIMETERS	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10	---	0.043	---	1.10
A1	0.002	0.006	0.05	0.15	0.002	0.006	0.05	0.15
B	0.010	0.014	0.25	0.36	0.010	0.016	0.25	0.40
C	0.005	0.007	0.13	0.18	0.005	0.009	0.13	0.23
D	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
e	0.0256 BSC		0.65 BSC		0.0256 BSC		0.64 BSC	
E	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
H	0.188	0.198	4.78	5.03	0.193 BSC		4.9 BSC	
L	0.016	0.026	0.41	0.66	0.016	0.027	0.40	0.70
α	0°	6°	0°	6°	0°	6°	0°	6°
S	0.0207 BSC		0.5250 BSC					



DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.037	0.043	0.94	1.10
A1	0.002	0.006	0.05	0.15
D1	0.116	0.120	2.95	3.05
D2	0.114	0.118	2.89	3.00
E1	0.116	0.120	2.95	3.05
E2	0.114	0.118	2.89	3.00
E	0.187	0.199	4.75	5.05
L	0.0157	0.0275	0.40	0.70
L1	0.037 REF		0.940 REF	
b	0.007	0.0106	0.177	0.270
e	0.0197 BSC		.500 BSC	
c	0.0035	0.0078	0.090	0.200
S	0.0196 REF		.498 REF	
α	0°	6°	0°	6°

Package Information (continued)



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050		1.27	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27

	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	MS012
D	0.189	0.197	4.80	5.00	8	A
D	0.337	0.344	8.55	8.75	14	B
D	0.386	0.394	9.80	10.00	16	C

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. LEADS TO BE COPLANAR WITHIN .102mm (.004")
4. CONTROLLING DIMENSION: MILLIMETER
5. MEETS JEDEC MS012-XX AS SHOWN IN ABOVE TABLE
6. N = NUMBER OF PINS

MAXIM 120 SAN GABRIEL DR SUNNYVALE CA 94086 FAX (408) 737 7194
PROPRIETARY INFORMATION

PACKAGE FAMILY OUTLINE: SOIC .150"
TITLE

1/1

21-0041 A
DOCUMENT CONTROL NUMBER REV