Le87401

Datasheet

PLC Single Channel Line Driver BD870 Series

May 2018

Contents

1 Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

1.1 Revision 6.0

Revision 6.0 was published in May 2018. The format of this document was updated to the latest template.

1.2 Revision 5.0

Revision 5.0 was published in November 2013. The following is a summary of changes done in revision 5.0 of this document.

- Added minimum and maximum values. Noted guaranteed by design parameters. For more information, see Electrical Specifications (see page 7).
- Changed from Advance to Preliminary.
- Updated the RoHS statement in Ordering Information section. For more information, see Ordering Information (see page 18).
- Updated the usable VS supply voltage in Operating Ranges table. For more information, see Operating Range (see page 9).
- Updated R_{REF} in the Device Specifications section. For more information, see Electrical Specifications (see page 7).
- Updated the Internal Reference Current section. For more information, see of Internal Reference Current (see page 16).

1.3 Revision 4.0

Revision 4.0 was published in June 2013. The following is a summary of changes done in revision 4.0 of this document.

- Updated the Class Gh operation. For more information, see Class GH Operation (see page 5).
- Updated the Le87401 Pin Descriptions table. For more information, see Pin Descriptions (see page 12).
- Added the Typical Performance Characteristics section. For more information, see Typical Performance Characteristics (see page 10).

1.4 Revision 3.0

Revision 3.0 was published in May 2013. The following is a summary of changes done in revision 3.0 of this document.

- Updated the RoHS statement in Ordering Information section. For more information, see Ordering Information (see page 18).
- Updated the usable VS supply voltage in Operating Ranges table. For more information, see Operating Range (see page 9).
- Defined R_{REF} in the Device Specifications section. For more information, see Electrical Specifications (see page 7).
- Added the Internal Reference Current section. For more information, see of Internal Reference Current (see page 16).

1.5 Revision 2.0

Revision 2.0 was published in April 2013. The following is a summary of changes done in revision 2.0 of this document.

- Added feature descriptions. For more information, see Features (see page 3).
- Added Tape and Reel packaging diagram. For more information, see 16-Pin QFN Outline Drawing (see page 14).

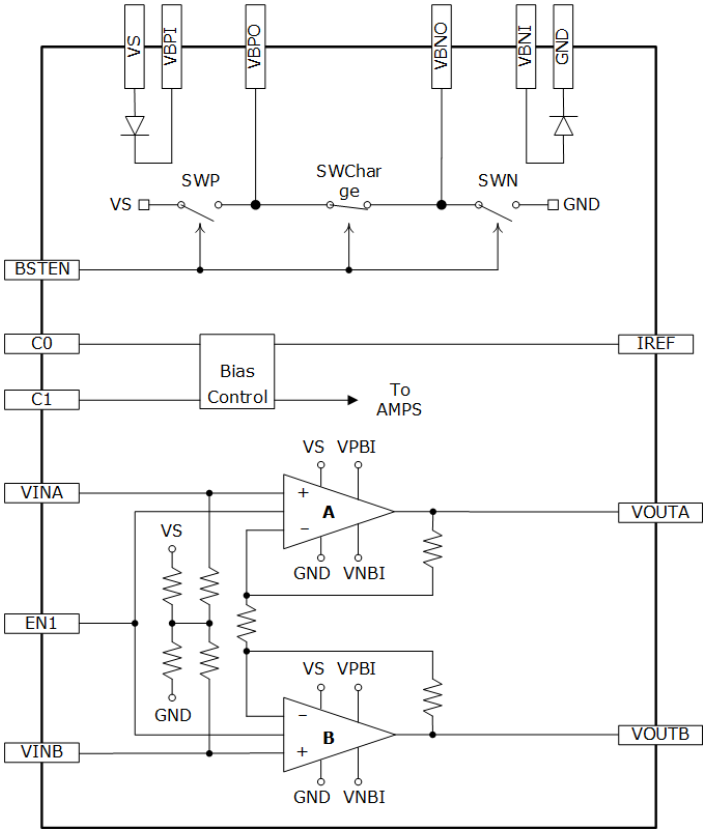
1.6 Revision 1.0

Revision 1.0 was published in January 2013. It was the first publication of this document.

2 Product Overview

Le87401 is a single channel line driver designed to work in home plug alliance HPAV2 systems, G.HN, and MOCA. This single channel device can be used for single-in, single-out (SISO) operation. Potentially, two single channel devices can work together for multiple-in, multiple-out (MIMO) operation. Le87401 can drive a line impedance of 100 Ω to 12 Ω through a proper transformer and deliver superior performance with power efficiency using Class GH operation.

Figure 1 • Le87401 Block Diagram



2.1 Features

Le87401 has the following important features.

- Designed for HPAV2 standard
- MIMO or SISO operation
- Single channel operation
- Small 16-pin, 4 × 4 mm package
- Low power operation
- Class GH operation
- Supports HPAV2 power save mode
- Channel enable/disable control
- Capable of driving line impedance between 12 Ω to 100 Ω
- Operations to 86 MHz
- 10 to 12 V operation

2.2 Applications

The following applications use Le87401.

- Power line communications
- Home networking

3 Functional Description

Le87401 operation state control is depicted in the following table. For active operation, the channel is either in enable state (power-up mode) when EN1 = 1 or disable state (power-down mode) when EN1 = 0. A Standby state (long-term sleep mode) is also provided. C0 and C1 control state selection. A setting of C0 = C1 = 0 overrides EN1 and places the channel in standby state. Standby is the default state in which power is initially supplied.

Table 1 • Operation State Control

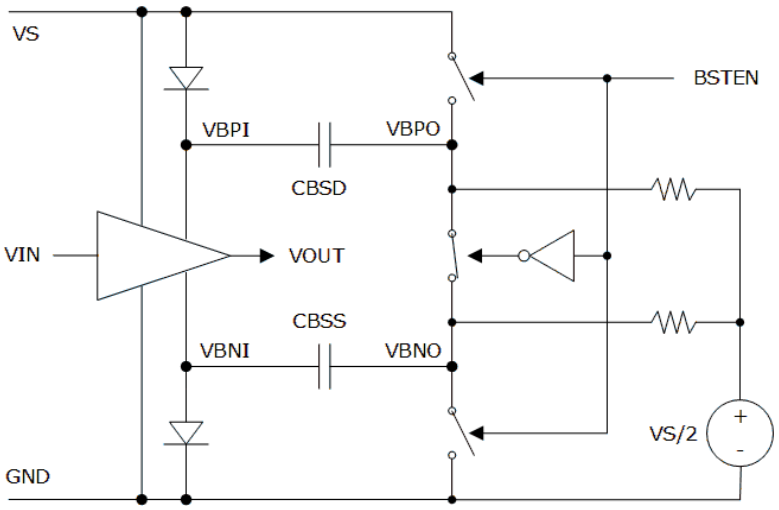
EN1	C1	C0	Device State	Mode
1	1	1	Enable full power	Power-up
1	0	1	Enable 90% power	
1	1	0	Enable 80% power	
x	0	0	Standby	Sleep
0	1	1	Disable	Power-down
0	1	0		
0	0	1		

Note: X = Do not care.

3.1 Class GH Operation

The device operates and drives signals using a low-voltage supply. The device includes circuitry that stores voltage on external boost capacitors. When the capacitors are switched on, as if a high supply in the Class G operation is switched on, the supply to the output of the drive amplifiers is increased, similar to a Class H operation, thereby voiding saturation and any associated distortion. The GH operation is shown in the following figure. VS is the external low-voltage supply. External boost capacitors, CBSD, and BSS are charged up, each to about half of VS, when BSTEN is low. The supplies to the output stage of the drive amplifiers are boosted up when BSTEN is high. The timing diagram is shown in Timing Diagram for Class-H Operation (see page 6).

Figure 2 • Class GH Operation



3.1.1 Boost Capacitor

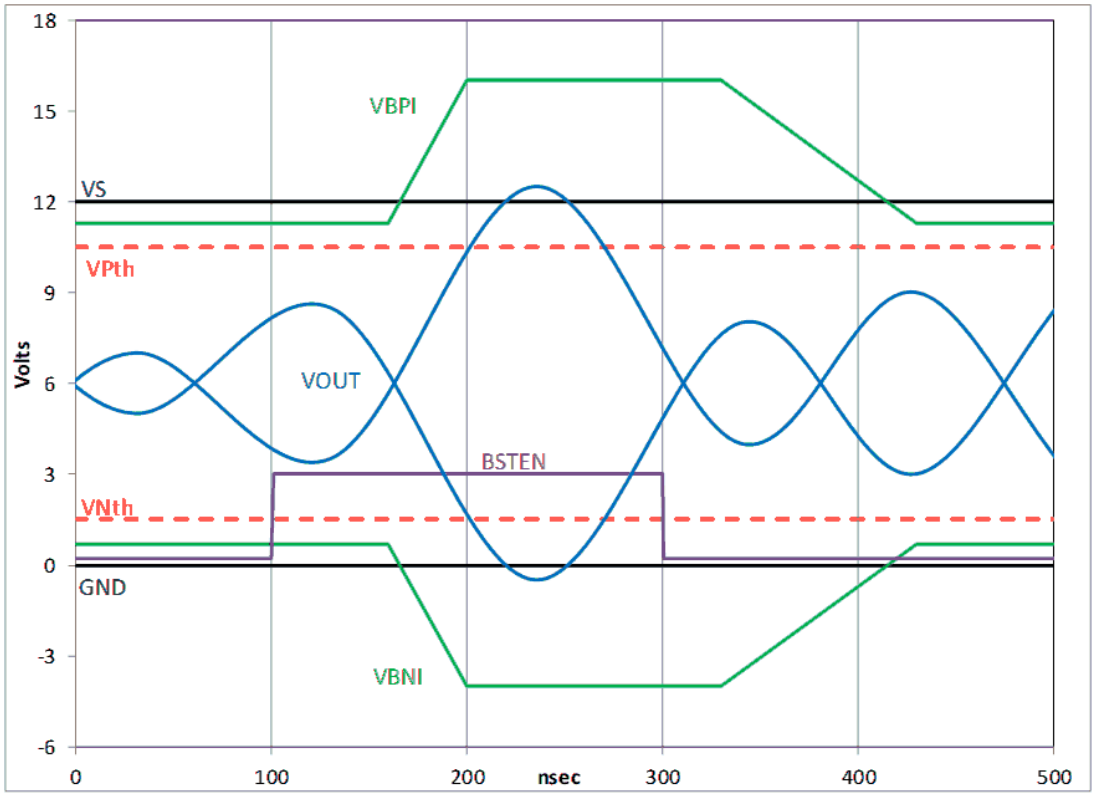
The minimum value for the boost capacitor (CBSD and CBSS) is dependent on the amplitude statistics of the transmitted waveform. There is no maximum value for the boost capacitor.

3.1.2 Operation Without Boosting

The device may be used in an application that does not require the boosting supply function. In this situation, the following actions are allowed.

- Connect VBPI pin to VS and VBNI pin to GND, externally. This enables a wider VOUT range at the same VS voltage.
- Remove external boosting capacitors, CBSD, and CBSS.
- Increase VS beyond the operating ranges shown in Operation Range (see page 9), but must remain within the absolute maximum rating shown in Absolute Maximum Ratings (see page 8).

Figure 3 • Timing Diagram for Class H Operation



Notes on Class GH operation:

- VS is the voltage supply to the chip and must meet operating range restrictions listed in Operation Range (see page 9).
- VBPI and VBNI function as supply rails to the line driver amplifiers. When BSTEN is low, VBPI = VS - Vdiode and VBNI = GND + Vdiode where Vdiode is about 1 V. When BSTEN is high, VBPI and VBNI are boosted beyond the chip supply rails through external boosting capacitors.
- VPth and VBth mark the VOUT range limit while BSTEN is low, shown in the previous figure. If VOUT exceeds the threshold, BSTEN is set high with an adequate warning time (100 ns as shown in previous figure) before the event.

4 Electrical Specifications

The following sections provide the available electrical specifications for Le87401. The following table gives the device parameters, conditions, and the limits.

VS = 12 V, R_{REF} = 75 kΩ, and device in enable full power state using the basic test circuit, unless otherwise specified. Typical conditions: T_A = 25 °C. Minimum/maximum parameters: T_A = 0 °C to 85 °C.

Table 2 • Electrical Specifications

Parameter	Condition	Minimum	Typical	Maximum	Unit
Supply Current					
Ivs	Quiescent, VINA/B floating				
– Enable full power state		40	57	73	mA
– Enable 90% power state		36	51	66	mA
– Enable 80% power state		32	46	59	mA
– Enable 80% power state	VS = 10 V, R_{REF} = 130 kΩ		42		mA
– Disable state		1.4	2	2.8	mA
– Standby state		0.2	0.45	1	mA
Control Input (C0/1, EN1, BSTEN) Characteristics					
Internal 50 kΩ pull-down on all control inputs					
V_{IH}		1.2		3.6	V
V_{IL}		–0.3		0.6	V
I_{IH}			75	120	µA
I_{IL}			10	20	µA
Channel Input (VINA/B) Characteristics					
Input offset voltage		–35		35	mV
Differential input impedance	VINA - VINB, VINC - VIND	13	15	18	kΩ
Channel Output (VOUTA/B) Characteristics					
Output voltage	Boosting[1]		12.5		V_{PK}
	Not Boosting, BSTEN = 0		8		V_{PK}
Output current	RLoad = 10 Ω		600		mA
Disabled output impedance[1]	Differential		560		Ω
Channel Dynamic Characteristics					
Voltage gain	VOUT/VIN at 1 MHz	5.5	6.5	7.5	V/V
Bandwidth[1]	–3 dB		95		MHz
Input referred noise[1]	Differential		15		nV /√HZ
MTPR[1]	Pload = 40 mW				
	0.5 MHz–30 MHz		–62		dBc
	30 MHz–86 MHz		–32		dBc
Enable time[1]	Between Disable and any Power-up state		500		ns
Disable time[1]			500		ns
Boost Characteristics					

Parameter	Condition	Minimum	Typical	Maximum	Unit
BSTEN warning time[1]	Time from BSTEN to VOUT crossing threshold		100		ns
Thermal Shutdown					
Thermal shutdown temperature[1]			170		°C

Note:

1. Guaranteed by design and device characterization.

4.1 Absolute Maximum Ratings

Stresses above the values listed under absolute maximum ratings can cause permanent device failure. Functionality at or above these limits is not implied. Exposure to absolute maximum ratings for extended periods can affect device reliability. The following table shows the absolute maximum ratings of Le87401.

Table 3 • Absolute Maximum Ratings

Parameter	Rating
Storage temperature	–65 °C ≤ T_A ≤ 150 °C
Operating junction temperature	–40 °C ≤ T_J ≤ 150 °C[1]
VS to GND	–0.3 V to 16 V
Driver inputs VINA/B	VS to GND
Control inputs C0/1, EN1, BSTEN with respect to GND	–0.3 V to 4 V
Continuous driver output current	200 mArms
ESD immunity (human body model)	JESD22 Class 2 compliant
ESD immunity (charge device model)	JESD22 Class IV compliant

Note:

1. Continuous operation above 145 °C junction temperature may degrade device long term reliability.

4.2 Thermal Resistance

The thermal performance of a thermally enhanced package is assured through optimized printed circuit board layout. Specified performance requires that the exposed thermal pad is soldered to an exposed copper surface of same dimension, which, in turn, conducts heat through multiple vials to larger internal copper planes.

4.3 Operating Ranges

Microsemi guarantees the performance of this device over 0 °C to 85 °C temperature range by conducting electrical characterization and a single insertion production test coupled with periodic sampling. These procedures comply with the Telcordia GR-357-CORE generic requirements for assuring the reliability of components used in telecommunications equipment.

The following table lists the operating range of the device.

Table 4 • Operation Range

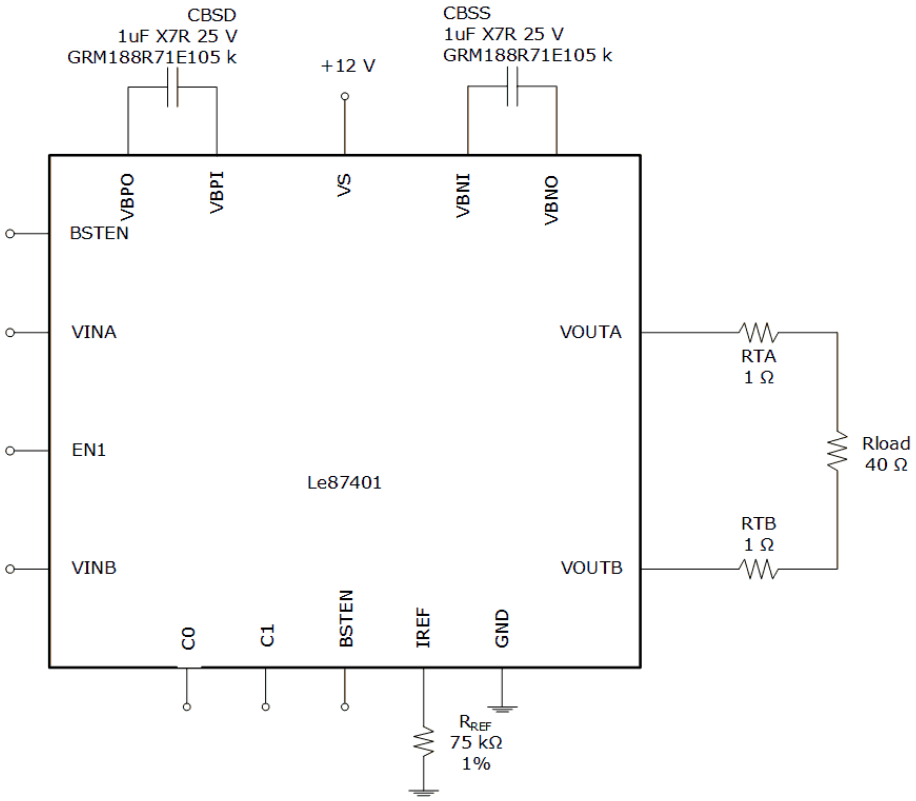
Parameter	Rating
Ambient temperature	0 °C to 85 °C
VS with respect to GND	10 V to 12 V, +/- 5%

Potential MIMO operation requires two Le87401 devices. MIMO operation has the same device specification as SISO operation but more power is delivered to the line in SISO operation.

4.4 Test Circuit

The following figure shows the basic test circuit.

Figure 4 • Basic Test Circuit



4.5 Typical Performance Characteristics

Some typical performance characteristics are shown in the following figures.

Figure 5 • Differential Gain

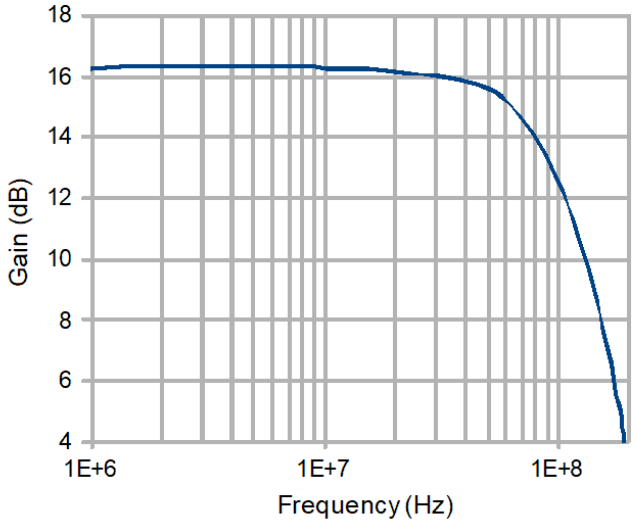


Figure 6 • Disabled Output Impedance

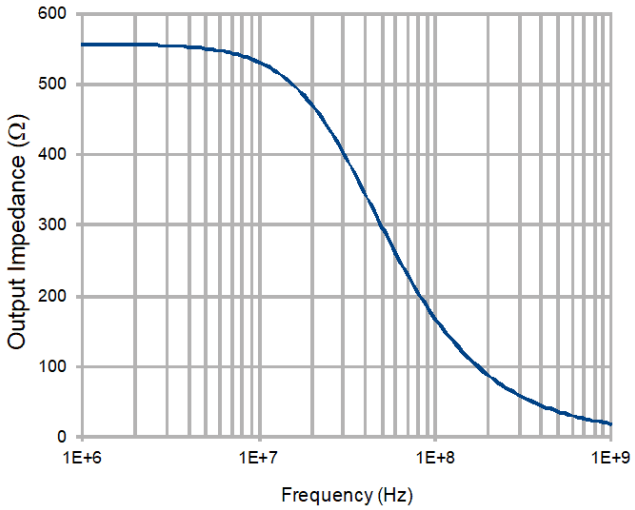
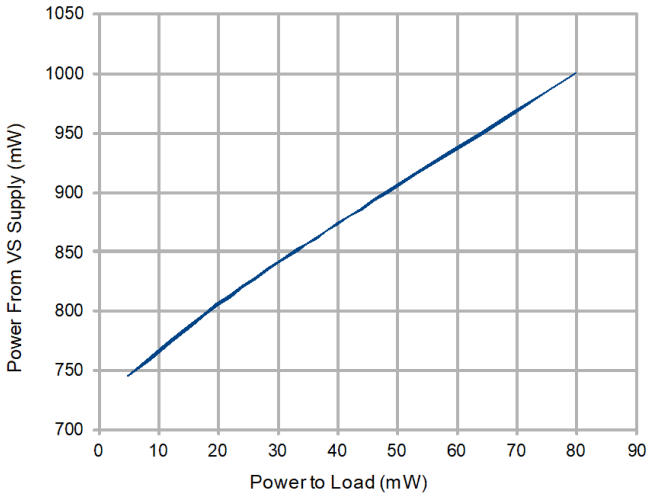


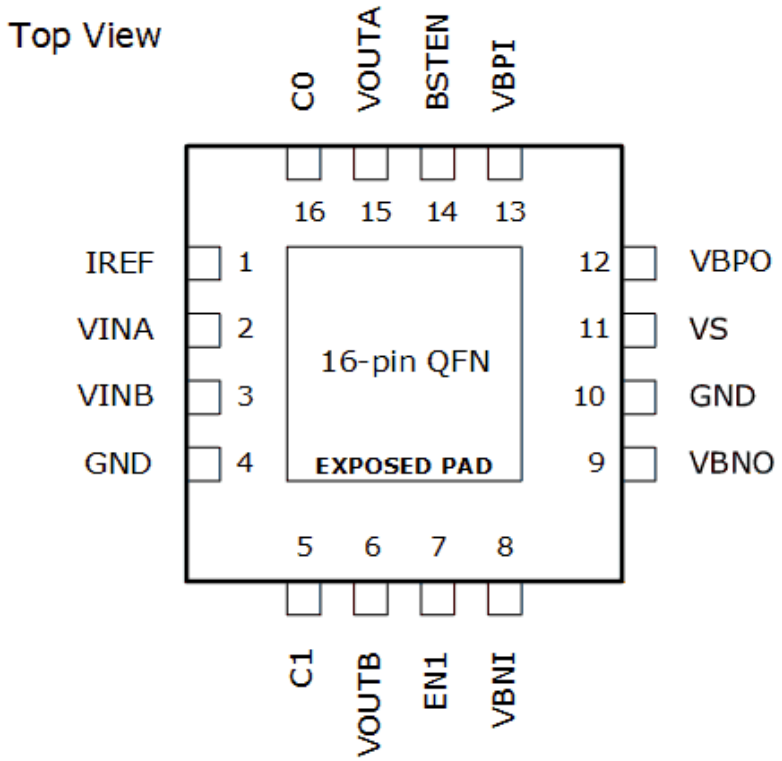
Figure 7 • Supply Power Versus Load Power



5 Pin Descriptions

The following figure shows the device pin diagram.

Figure 8 • Le87401 Pin Diagram



Note:

1. Pin 1 is marked for orientation.
2. The device incorporates an exposed die pad on the underside of its package. The pad acts as a heat sink and must be connected to a copper plane through thermal vials for proper heat dissipation. It is electrically isolated and may be connected to GND.

The following table lists the pin name, corresponding pin number, type, and the descriptions.

Table 5 • Pin Descriptions

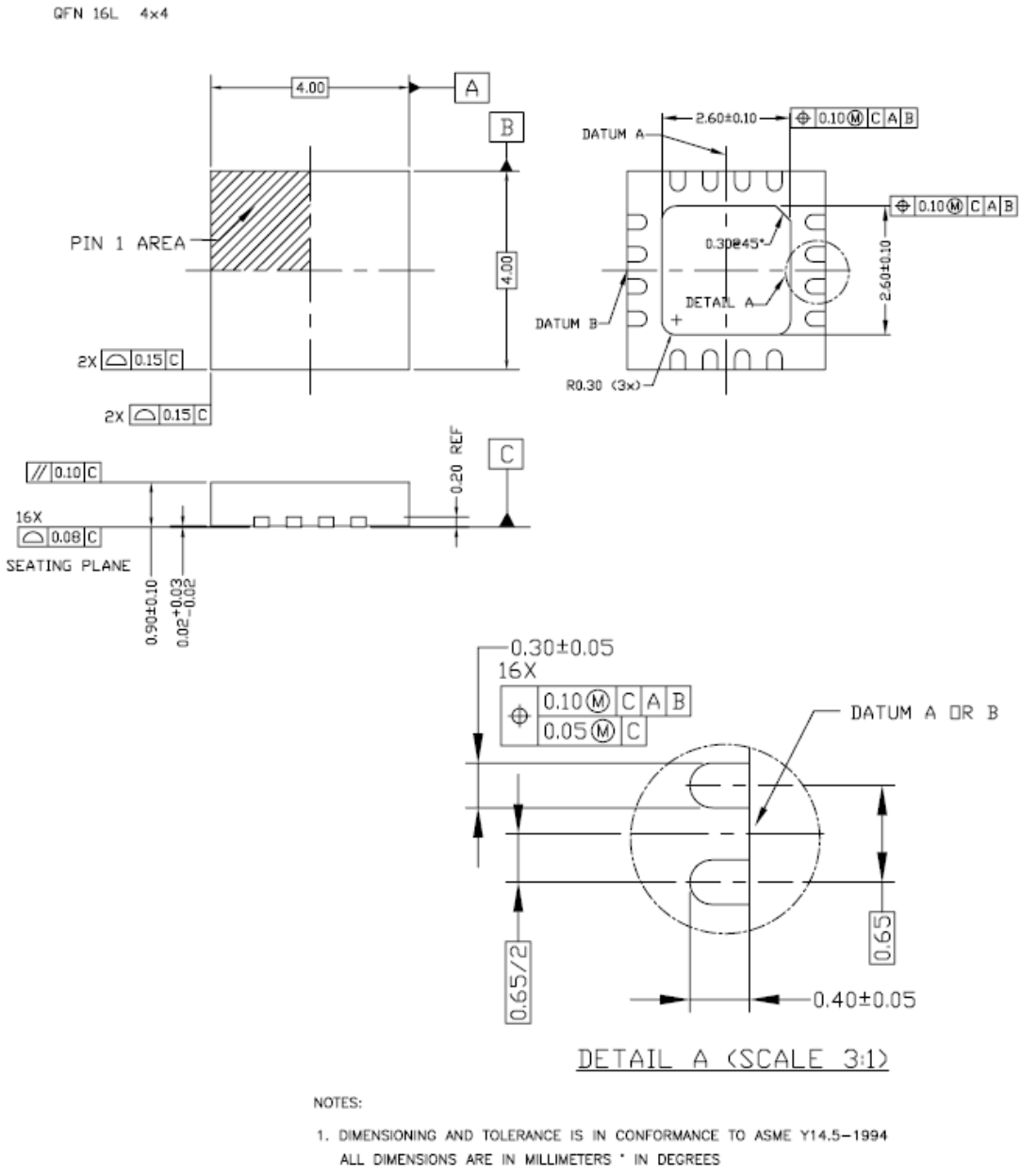
Pin Name	Pin #	Types	Description
IREF	1	Input	Device internal reference current. Connect resistor R_{REF} to GND.
EN1	7	Input	Channel A and B enable/disable control
VIA	2	Input	Amplifier A input
VINB	3	Input	Amplifier B input
VOUTA	15	Output	Amplifier A output
VOUTB	6	Output	Amplifier B output
C0, C1	16, 5	Input	Sets operation state when channel enabled
VBPO	12	Output	Connect a capacitor to VBPI
VBPI	13	Input	Connects to VS through an internal diode

Pin Name	Pin #	Types	Description
VS	11	Power	Power supply
GND	4, 10	Ground	Low noise analog ground
VBNI	8	Input	Connects to GND through an internal diode
VBNO	9	Output	Connect a capacitor to VBNI
BSTEN	14	Input	Boost enable

6 Package Information

The following figure shows the outline drawing of the Le87401 device.

Figure 9 • 16-Pin QFN Outline Drawing



6.1 Package Assembly

The green package devices are assembled with enhanced, environmental compatible lead-free, halogen-free, and antimony-free materials. The leads possess a matte-tin plating which is compatible with conventional board assembly processes or newer lead-free board assembly processes. Refer to IPC /JEDEC J-Std-020 for recommended peak soldering temperature and solder reflow temperature profile.

7 Design Considerations

Le87401 integrates two high-power line driver amplifiers. The amplifiers are designed for low distortion for signals up to 86 MHz. A typical application interface circuit is shown in Typical Application Circuit (see page 17). The amplifiers have identical positive gain connections with common-mode rejection. Any DC input errors are duplicated and create common-mode rather than differential line errors.

7.1 Internal Reference Current

Resistor R_{REF} sets the internal reference current of the Le87401 device. The standard value for R_{REF} is 75 kΩ, this value was used for all specifications in this data sheet. Increasing the value of R_{REF} reduces device power dissipation but also lowers the available drive bandwidth. Do not exceed an R_{REF} value of 130 kΩ.

7.2 Input Considerations

The driving source impedance should be less than 100 nH to avoid any ringing or oscillation.

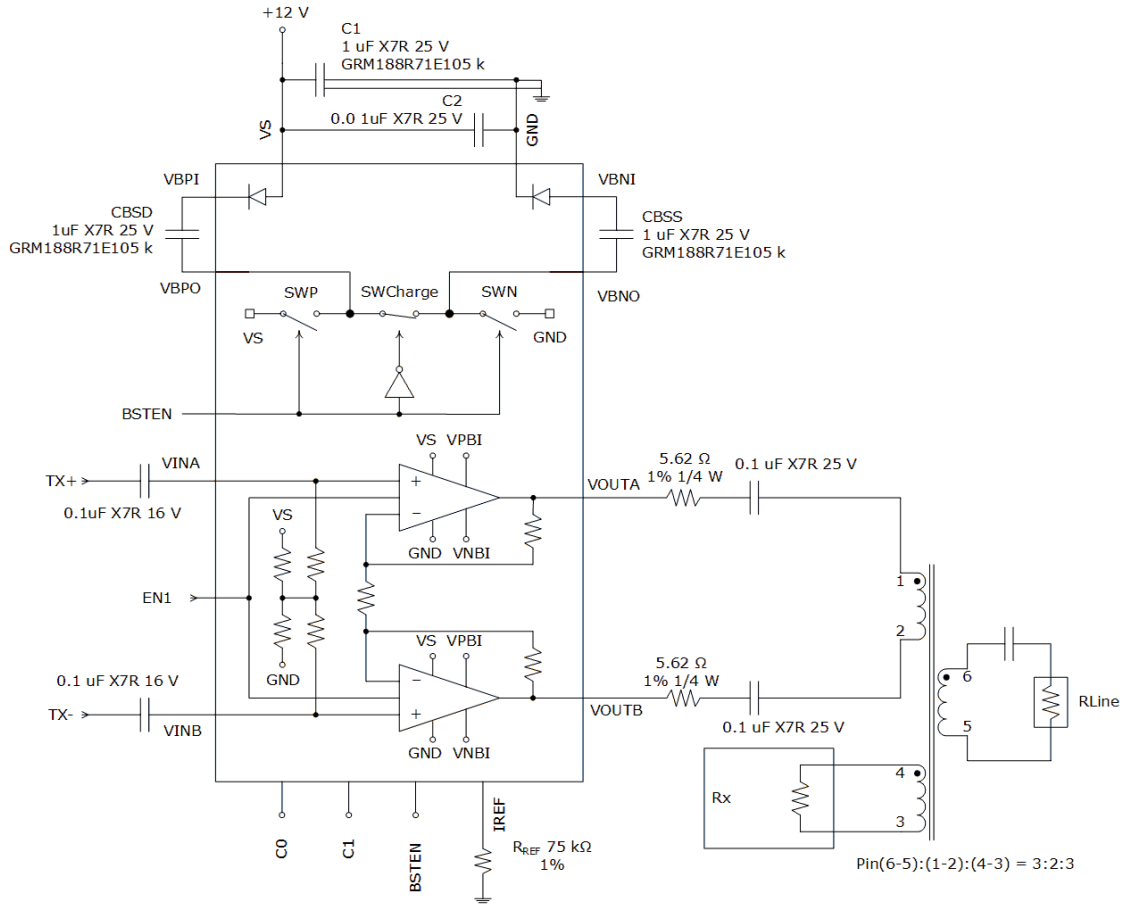
7.3 Output Driving Considerations

The internal metallization is designed to drive 200 mArms sinusoidal current and there is no current limit mechanism. Driving lines without a series resistor is not recommended. If a DC current path exists between the two outputs, a DC current can flow through the outputs. To avoid DC current flow, the most effective solution is to place DC blocking capacitors in series with the output as shown in the following figure.

7.4 Power Supplies and Component Placement

The power supplies should be well bypassed; with decoupling placed close to the Le87401. The following figure shows the typical application circuit for Le87401.

Figure 10 • Typical Application Circuit



8 Ordering Information

The following list shows the ordering part numbers to be used while ordering Le87401.

- Le87401NQC 16-pin QFN Green Pkg. Tray
- Le87401NQCT 16-pin QFN Green Pkg. Tape and Reel

The green package is Halogen free and meets RoHS 2 Directive 2011/65/EU of the European Council to minimize the environmental impact of electrical equipment.