

Evaluating the **ADA4870** High Speed, High Output Current Amplifier

FEATURES

Enables easy evaluation of the **ADA4870**
Single-supply or dual-supply operation
Robust thermal management

APPLICATIONS

BTS envelope tracking
Power FET driver
Ultrasound
Piezo driver
PIN diode driver
Waveform generation
ATE
CCD panel driver

GENERAL DESCRIPTION

The **ADA4870** is a 40 V, unity-gain stable, high speed current feedback amplifier capable of delivering 1 A of output current from a 40 V supply. Manufactured using the Analog Devices, Inc., proprietary high voltage XFCB process, the innovative architecture of the **ADA4870** enables high output power, high

speed signal processing solutions in a variety of demanding applications.

The **ADA4870** is ideal for driving high voltage power FETs, piezo transducers, PIN diodes, and a variety of other demanding applications that require high speed from high supply voltage and high current output.

The **ADA4870** is available in a power SOIC package (PSOP_3) featuring an exposed thermal slug that provides high thermal conductivity to the PCB and heat sink enabling efficient heat transfer for improved reliability in demanding environments. The **ADA4870** operates over the industrial temperature range (−40°C to +85°C).

The evaluation board, **ADA4870ARR-EBZ**, provides a platform for quick and easy evaluation of the **ADA4870**. Figure 1 shows the top side of the evaluation board. Figure 2 shows the bottom side of the board with the large exposed copper area for applying a heat sink as needed.

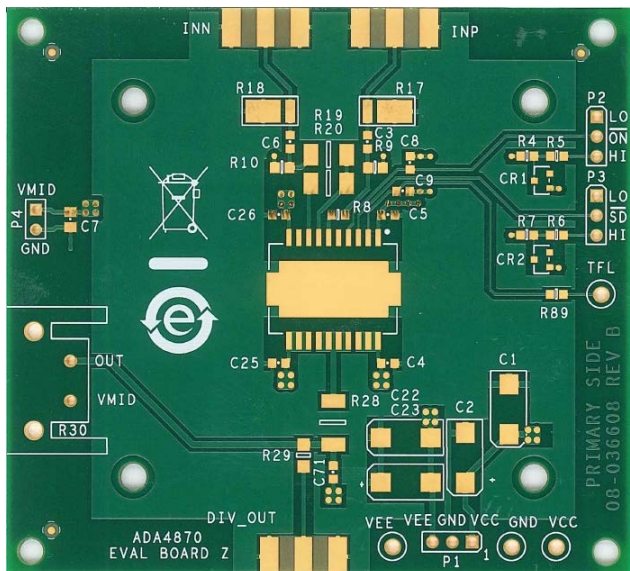


Figure 1. Evaluation Board, Top Side

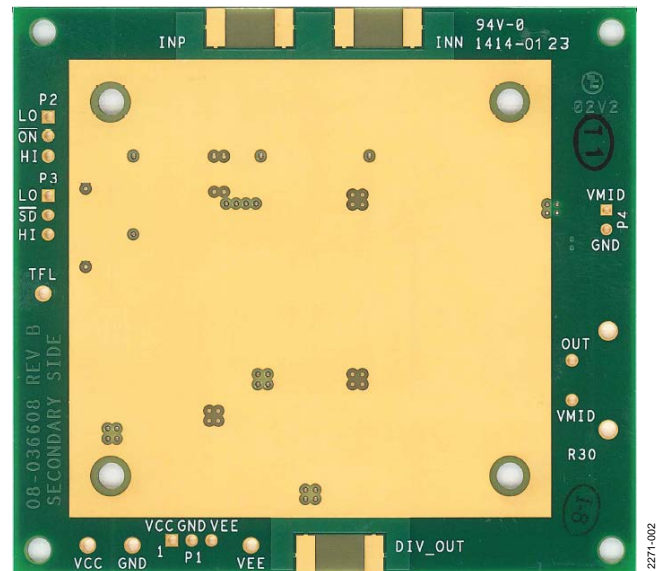


Figure 2. Evaluation Board, Bottom Side

TABLE OF CONTENTS

Features	1	$\overline{\text{ON}}$, Initial Power-Up, and Short Circuit	4
Applications.....	1	Shutdown ($\overline{\text{SD}}$)	4
General Description	1	Thermal Monitor/Short-Circuit Flag (TFL).....	4
Revision History	2	Thermal Design	4
Evaluation Board Hardware.....	3	Thermal Performance.....	4
Board Stack Up	3	Schematic.....	6
Power Supplies and Decoupling.....	3	Bill of Materials.....	7
Mid-Supply Bias (VMID).....	3		
Input and Output.....	3		

REVISION HISTORY

6/14—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

BOARD STACK UP

The ADA4870 evaluation board is a 6-layer board. All signal routing is on the top layer while the bottom layer is an exposed copper ground plane to facilitate the use of a heat sink, if needed, for high power dissipation. Internal layers 2 through 5 consist of the GND, VCC, VMID, and VEE planes.

POWER SUPPLIES AND DECOUPLING

The ADA4870 evaluation board can be powered using a single supply or dual supplies. The total supply voltage ($V_{CC} - V_{EE}$) should be between 10 V and 40 V. The board provides sufficient power supply decoupling for high current, fast slewing signals with 10 μ F and 22 μ F tantalum capacitors (C1, C2, C22, and C23) where the supply voltage enters the board, and 0.1 μ F ceramic chip capacitors (C4, C5, C25, and C26) in close proximity to each supply pin.

MID-SUPPLY BIAS (VMID)

The ADA4870 should be referenced to a mid-supply dc operating point. When using dual, symmetrical supplies, this can be accomplished by jumping the VMID plane to GND using the 2-pin header, P4. When using a single supply or asymmetrical dual supplies, the mid-supply reference can be established by applying the appropriate voltage to the VMID pin of P4 using a low impedance source, such as a dc supply.

INPUT AND OUTPUT

The evaluation board uses edge mount SMA connectors on input and output for easy interfacing to signal sources and test equipment. When evaluating high voltage output signals using standard 50 Ω test equipment, a 2.43 k Ω resistor (R29) provides a signal division of 49.6 at the DIV_OUT SMA connector. The board has footprints for a capacitor load (C71) and a TO220 resistor load with heat sink (R30), both referenced to the VMID plane.

To facilitate evaluation using standard 50 Ω signal sources, each input has high power 50 Ω termination resistors (R17, R18) referenced to GND. Each input also has ac coupling capacitors (C3, C6), and bias resistors (R9, R10) to VMID.

The combination of the input termination resistors, input coupling capacitors, and VMID bias resistors is dependent on how the circuit and supplies are configured. Table 1 shows the configuration of these components for various circuits and supplies. The ac input cases assume the amplifier is being driven from a ground referenced 50 Ω signal generator.

Figure 5 shows the evaluation board schematic.

Table 1. Configuration of Input Components

Supply ¹	INP Signal	INN Signal	R17	R18	R9	R10	C3 ²	C6 ²
Dual	ac		50 Ω	0 Ω ³	DNI	DNI	0 Ω	0 Ω
Dual		ac	50 Ω	50 Ω	DNI	DNI	0 Ω	0 Ω
Dual	dc		50 Ω	0 Ω ³	DNI	DNI	0 Ω	0 Ω
Dual		dc	50 Ω	50 Ω	DNI	DNI	0 Ω	0 Ω
Single	ac		50 Ω	50 Ω ⁴	1 k Ω	0 Ω	Capacitor ⁵	DNI
Single		ac	50 Ω ⁶	50 Ω	0 Ω	DNI	DNI	Capacitor ⁵
Single	dc		DNI	50 Ω ⁴	1 k Ω	0 Ω	0 Ω	DNI
Single		dc	50 Ω ⁶	DNI	0 Ω	DNI	DNI	0 Ω

¹ Dual implies symmetrical supplies; single implies any nonsymmetrical supplies.

² In many cases, this is a 0 Ω resistor instead of a capacitor.

³ This can be 50 Ω if a short is placed on the INN connector.

⁴ This can be 50 Ω because C6 is open.

⁵ This is a user defined value.

⁶ This can be 50 Ω because C3 is open.

$\overline{\text{ON}}$, INITIAL POWER-UP, AND SHORT CIRCUIT

The $\overline{\text{ON}}$ pin is used to turn on the amplifier after initial power-up and after a short-circuit event. The pin is referenced to the negative supply (V_{EE}).

After initial power-up, the $\overline{\text{ON}}$ pin must be pulled low to ensure that the amplifier is turned on. Subsequently, floating the $\overline{\text{ON}}$ pin enables the short-circuit protection feature while the amplifier remains on. While $\overline{\text{ON}}$ is held low, the short-circuit protection feature is disabled.

When a short-circuit condition is detected, the amplifier is disabled, the supply current drops to about 5 mA, and the TFL pin outputs a dc voltage of ~300 mV. To turn the amplifier back on after a short-circuit event, follow the above sequence for initial power-up.

Pulling the $\overline{\text{ON}}$ pin high disables the amplifier and causes the supply current to drop to about 5 mA, as if a short-circuit condition had been detected.

On the evaluation board, Pin 1 of the $\overline{\text{ON}}$ header (P2) is tied to V_{EE} while Pin 3 uses a 5 V Zener diode (CR1) to set the high level at 5 V above V_{EE} .

The impedance at $\overline{\text{ON}}$ is ~20 k Ω . The $\overline{\text{ON}}$ pin is decoupled to V_{EE} via C8 to shunt noise away from $\overline{\text{ON}}$ and help avoid false triggers. Care should be taken to avoid direct contact with the pin.

SHUTDOWN ($\overline{\text{SD}}$)

Pulling the $\overline{\text{SD}}$ pin low places the amplifier in a low power shutdown state, reducing the quiescent current to about 750 μA . The center pin of the $\overline{\text{SD}}$ header (P3) should be jumped either low for shutdown or high when the amplifier is enabled. The pin should not be floated. When turning the amplifier back on from the shutdown state, pull the $\overline{\text{SD}}$ pin high and then pull the $\overline{\text{ON}}$ pin low. Following this sequence ensures turn on. Afterwards, the $\overline{\text{ON}}$ pin may be floated to enable short-circuit protection.

THERMAL MONITOR/SHORT-CIRCUIT FLAG (TFL)

The TFL pin can be used to monitor approximate changes in die temperature and to detect a short-circuit condition. During normal operation the pin outputs a dc voltage (referenced to V_{EE}) in the range of 1.5 V to 1.9 V that is relative to die temperature. The voltage on TFL changes at approximately $-3 \text{ mV}/^\circ\text{C}$ and can be used to indicate approximate increases in die temperature. When excessive die temperatures are detected,

the amplifier switches to an off state, dropping the supply current to about 5 mA, and TFL continues to report a voltage relative to the die temperature. When the die temperature returns to an acceptable level, the amplifier automatically resumes normal operation.

THERMAL DESIGN

In some applications, the ADA4870 could be required to dissipate as much as 10 W internally, possibly at elevated ambient temperatures of $+85^\circ\text{C}$. The evaluation board was designed to provide robust thermal management under these conditions.

The top of the board has an exposed copper area that gets solder attached to the exposed thermal pad on the ADA4870 PSOP package. This exposed copper area on the top is connected to the exposed copper ground plane on the bottom by an array of 136 thermal vias. The vias are filled with AE3030 thermally conductive epoxy to provide a low thermal resistance path through the board to the bottom layer. The single internal ground layer is also attached giving an incremental improvement in thermal mass.

When necessary, a heat sink can be mounted to the bottom exposed copper using the four mounting holes. The bottom side exposed copper plane and mounting holes are sized to accommodate either a VHS-45 or a VHS-95 heat sink.

THERMAL PERFORMANCE

The most thermally demanding condition for the ADA4870 is driving high dc current into a low resistive load. Figure 3 and Figure 4 show the die temperature vs. time as the internal power dissipation is increased over several hours. The ambient environment for Figure 3 is 25°C in still air; for Figure 4 the ambient environment is 85°C in still air. Figure 3 presents the die temperature without heat sink and with a VHS-45 heat sink, while Figure 4 shows die temperature without heat sink, with VHS-45 heat sink, and with VHS-95 heat sink. For both figures, the board is positioned with the bottom side facing up so that heat can more easily radiate away from the board.

Figure 3 and Figure 4 represent worst-case conditions of dc power dissipation and a still air environment. Using ac power dissipation or forced convection results in lower temperatures.

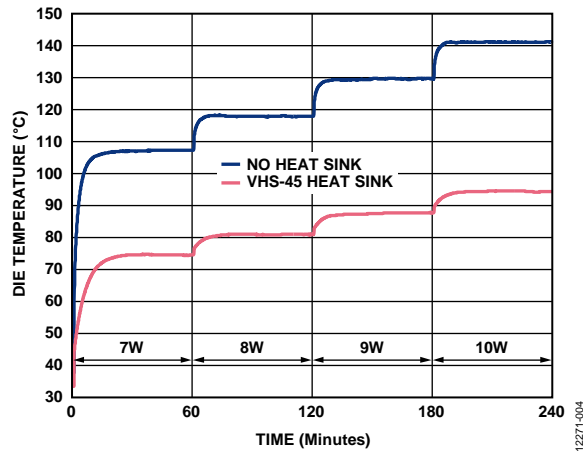


Figure 3. Die Temperature vs. Time and Internal Power Dissipation on the ADA4870 Evaluation Board, Ambient Temperature = 25°C, No Air Flow

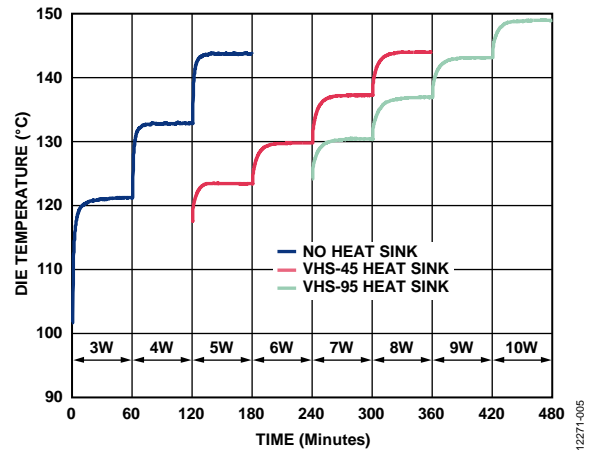


Figure 4. Die Temperature vs. Time and Internal Power Dissipation on the ADA4870 Evaluation Board, Ambient Temperature = 85°C, No Air Flow

SCHEMATIC

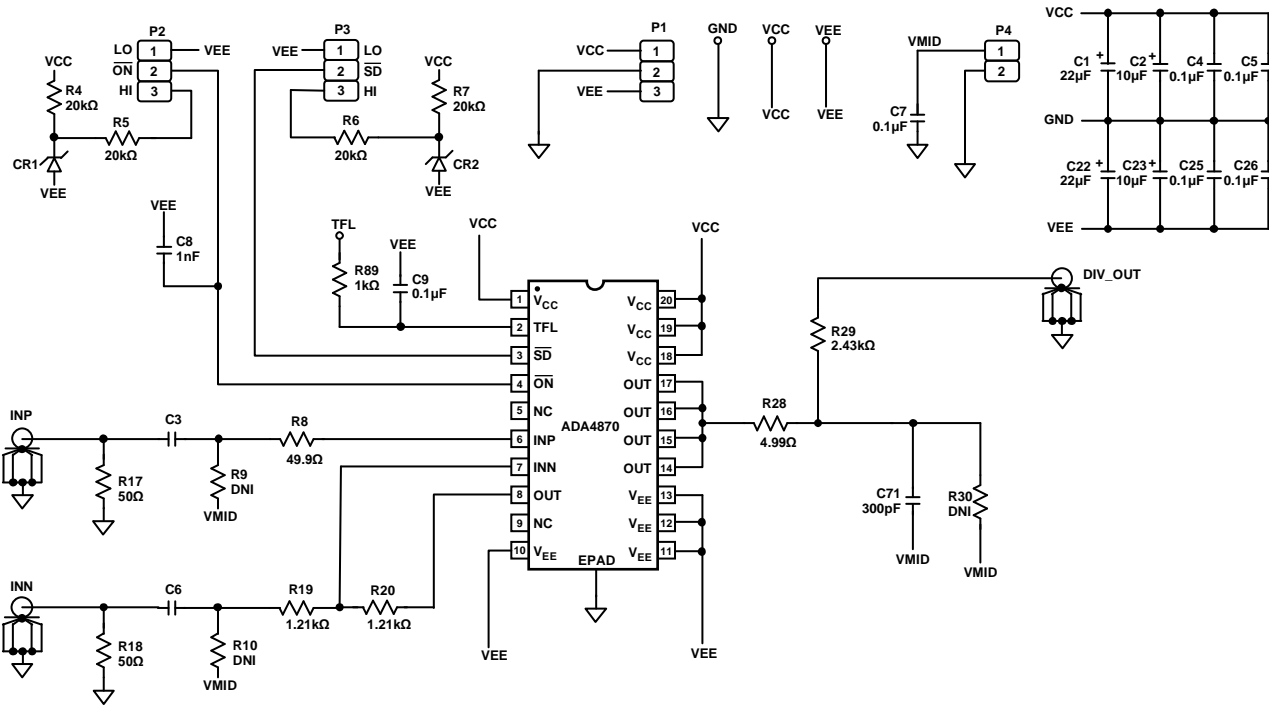


Figure 5. ADA4870 Evaluation Board Schematic

12271-003

BILL OF MATERIALS

Table 2.

Item	Qty	Reference Designator	Description	Value	Manufacturer/Part No.
1	1	N/A	ADA4870 customer board		Analog Devices/ADA4870ARR-EBZ
2	1	DUT1	ADA4870		Analog Devices/ADA4870
3	2	C1, C22	Capacitor, tantalum, 7343	22 μ F	AVX/TAJD226K050R
4	2	C2, C23	Capacitor, tantalum, 7343	10 μ F	AVX/TAJD106M050RNJ
5	5	C4, C5, C9, C25, C26	Capacitor, ceramic, X7R, 0603	0.1 μ F	AVX/06035C104KAT2A
6	2	C3, C6	Resistor, 0603	0 Ω	Panasonic/ERJ-3GEY0R00V
7	1	C7	Capacitor, ceramic, X7R, 0805, 50 V	0.1 μ F	Murata/GRM21BR71H104KA01L
8	1	C71	Capacitor, ceramic, COG, 0603, 50 V	300 pF	Murata/GRM1885C1H301JA01D
9	1	C8	Capacitor ceramic, X7R, 0603, 50 V	1 nF	AVX/06035C102KAT2A
10	2	R17, R18	Power resistor 10 W, R2010H47	50 Ω	Bourns/CHF2010CNP500LX
11	2	R19, R20	Resistor, 2010, 1%	1.21 k Ω	Panasonic/ERJ-12SF1211U
12	1	R28	Resistor, 2512, 1%	4.99 Ω	Vishay Dale/CRCW25124R99FKEG
13	1	R29	Resistor, 1206, 1%	2.43 k Ω	Panasonic/ERJ-8ENF2431V
14	4	R4, R5, R6, R7	Resistor, 0603, 1%	20 k Ω	Panasonic/ERJ-3EKF2002V
15	1	R8	Resistor, 0603, 1%	49.9 Ω	Panasonic/ERJ-3EKF49R9V
16	1	R89	Resistor, 0603, 1%	1 k Ω	Panasonic/ERJ-3EKF1001V
17	2	CR1, CR2	Diode, Zener, SOT23	5.6 V	ON Semiconductor/BZX84C5V6LT1G
18	3	P1, P2, P3	Conn-PCB berg HDR ST, male, 3P		Samtec/TSW-103-08-G-S
19	1	P4	Conn-PCB berg JMPR ST, male, 2P		FCI/69157-102HLF
20	3	INP, INN, DIV_OUT	Conn SMA end launch		Johnson/142-0701-801
21	1	VCC	Conn test point	Red	Components Corporation/TP104-01-02
22	1	VEE	Conn test point	Blue	Components Corporation/TP104-01-06
23	1	GND	Conn test point	Black	Components Corporation/TP104-01-00
24	1	TFL	Conn test point	Green	Components Corporation/TP104-01-05
25	2	R9, R10	Resistor, 0805	Not installed	
26	1	R30	Resistor, TO220	Not installed	

NOTES

**ESD Caution**

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.