∇ TRIPATH

EB-TA2024C

2x15W Class-T Digital Audio Amplifier Evaluation Board using Digital Power Processing^{TM} Technology

GENERAL DESCRIPTION

The EB-TA2024C evaluation board is based on the TA2024C, digital audio power amplifier from Tripath Technology. The board is designed to provide a simple and straightforward environment for the evaluation of the Tripath TA2024C. The board can be connected to a +12V supply using cables with standard banana connectors. Audio inputs are via standard RCA jacks. The TA2024C provides amplification for two channels of audio. Signal outputs are on four banana connectors to which any 4Ω or 8Ω passive speakers may be connected.

Features

- Class-T architecture
- Proprietary Digital Power Processing^{TM} Technology
- Requires single +12V power source
- Output Power (per channel @ V_S = 12V):
  - 15W per channel (4Ω, 10% THD+N)
  - 10W per channel (4Ω 0.1%, THD+N)
- Easy engineering evaluation platform for Tripath Technology's TA2024C product
- "Audiophile performance" typically:
  - 0.04% THD+N (9Wrms, 4Ω)
  - 0.18% IHF-IM (1Wrms, 4Ω)

- Efficiency - >88% @ full power (R_L = 8Ω)
- No heat sink required up to 15W per channel
- MUTE and SLEEP inputs
- Turn-on & turn-off pop suppression
- Intelligent short-circuit protection
- Intelligent over-temperature protection
- Connects to any passive 4/8Ω speakers
- Takes standard audio line output from any sound system
- Cost-effective 2-layer PCB design
- 36-pin Power SOP package

TA2024C Evaluation Board

Introduction

The EB-TA2024C was designed to provide the designer with a simple means of evaluating the performance and functionality of the TA2024 2x15W amplifier IC from Tripath Technology. The EB-TA2024C is very simple to operate and requires only the following to evaluate:

Stereo signal source
12V power supply (*not to exceed 14.0V*)
Two loads (*4-Ohm minimum*)

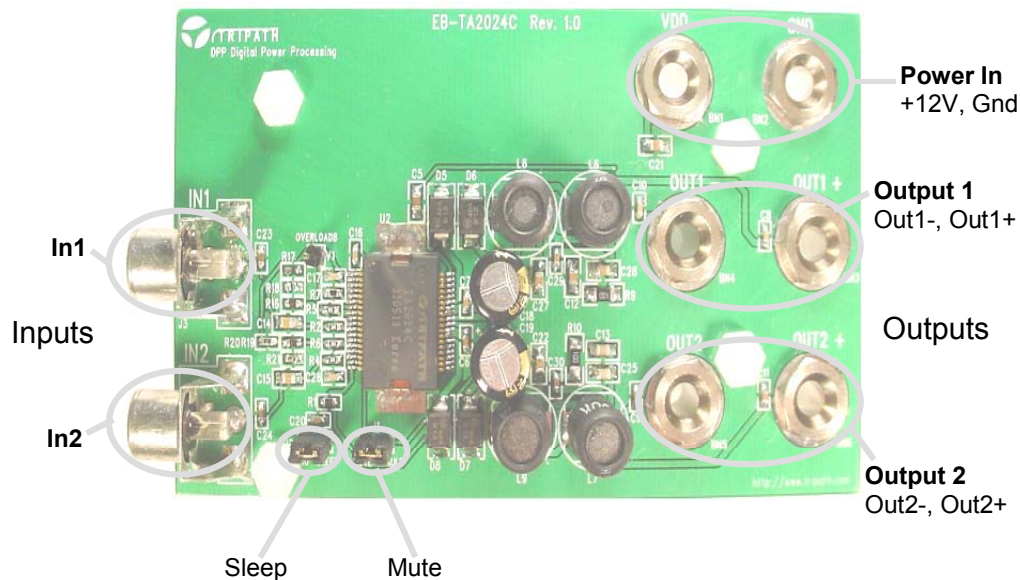For more information on the TA2024C, please refer to the TA2024C datasheet (www.tripath.com).

Figure 1: EB-TA2024C

Connection and Operation

Figure 1 shows the connections required for proper operation of the EB-TA2024C.

Input Connection

Audio input to the board is provided via two RCA female connectors.

Connector Name	Channel
IN1	Channel 1 Input
IN2	Channel 2 Input

Power Connection

The TA2024C requires a +12V power supply (14.0V max) to operate.

Power to the board is provided via two female banana connectors. The positive 12V from the power supply connects to the banana connector labeled VDD. The ground connection of power supply attaches to the banana connector labeled GND.

Connector Label	Description
VDD	Positive of the 12V Power supply
GND	Negative (GND) of 12V Power Supply

Warning: Do not exceed Maximum Operating Supply Voltage of 14.0V

Output Connection

There are four female banana connectors on the evaluation board for speaker output. The TA2024C has differential outputs (bridged), therefore, it requires two wires per channel to connect to each speaker.

Connector Label	Description
Out1+	Positive output of Channel 1
Out1-	Negative output of Channel 1
Out2+	Positive output of Channel 2
Out2-	Negative output of Channel 2

Jumper Settings

There are two jumpers on the EB-TA2024C board, which should both be connected (shorted) for normal operation. Jumper, J1 connects the FAULT output to the MUTE pin, allowing the part to Mute itself when a Fault condition (over-current, etc.) is detected. Jumper, J2 connects the SLEEP pin to GND, effectively disabling SLEEP for normal operation. If J2 is removed, the part will go into SLEEP mode.

Jumper	Purpose
J1	Connects FAULT to MUTE
J2	Connects SLEEP to GND

Gain Settings

The TA2024C amplifier gain can be adjusted by modifying external resister values. R2 and R5 are used to set the gain for Channel 1, while R4 and R6 set the gain for Channel 2.

The equation for the gain setting is:

$$A_V = 12 \cdot \left(\frac{R_f}{R_i} \right)$$

Where,

For channel 1: $A_{V\_Ch1} = 12 \cdot \left(\frac{R5}{R2} \right)$ For channel 2: $A_{V\_Ch2} = 12 \cdot \left(\frac{R6}{R4} \right)$

For a more detailed description, please refer to the TA2024C data sheet.

Output Stage layout Considerations and Component Selection Criteria

Proper PCB layout and component selection is a major step in designing a reliable TA2024C power amplifier. The supply pins require proper decoupling with correctly chosen components to achieve optimal reliability. The output pins need proper protection to keep the outputs from going below ground.
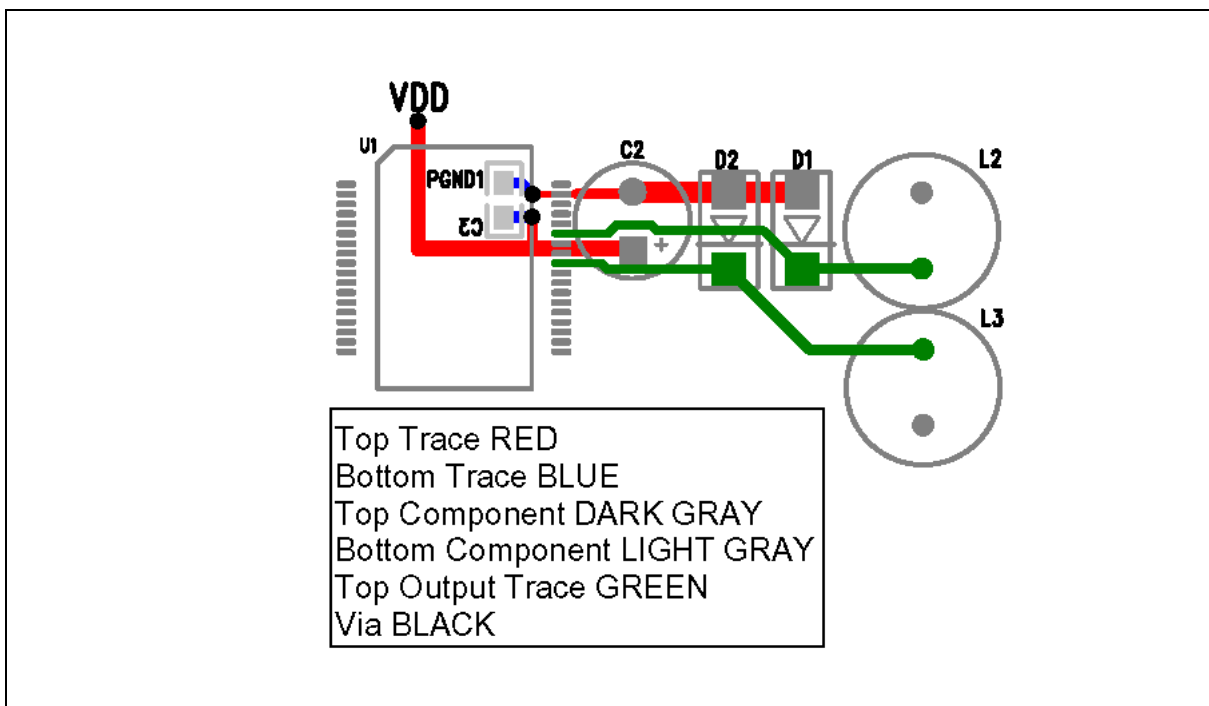
The reference layout above shows ideal component placement and routing for channel 1 (the same design criteria applies to channel 2). This shows that C3, a 0.1uF surface mount 0603 capacitor, should be the first component placed and must decouple VDD1 (pins 29 and 30) directly to PGND1 (pin35). C2, a low ESR, electrolytic capacitor, should also decouple VDD1 directly to PGND1. Both C2 and C3 may decouple VDD1 to a ground plane, but it is critical that the return path to the PGND1 pin of the TA2024C, whether it is a ground plane or a trace, be a short and direct low impedance path. Effectively decoupling VDD will shunt any power supply trace length inductance.

The diodes and inductors shown are for channel 1's outputs. D1 and L2 connect to the OUTP1 pin and D2 and L3 connect to the OUTM1 pin of the TA2024C. Each output must have a Schottky or Ultra Fast Recovery diode placed near the TA2024C, preferably immediately after the decoupling capacitors and use short returns to PGND1. These low side diodes, D1 and D2, will prevent the outputs from going below ground. To be optimally effective they must have a short and direct return path to its proper ground pin (PGND1) of the TA2024C. This can be achieved with a ground plane or a trace.
The output inductors, L2 and L3, should be placed close to the TA2024C without compromising the locations of the closely placed supply decoupling capacitors and output diodes. The purpose of placing the output inductors close to the TA2024C output pins is to reduce the trace length of the switching outputs. This will aid in reducing radiated emissions.

Please see the External Component Description section of the TA2024C Datasheet for more details on the above-mentioned components. The TA2024C Datasheet's Application/ Test Circuit refers to the low side diodes as D_O, The high side diodes as D_H, and both supply decoupling capacitors as C_{SW}.

Performing Measurements on the EB-TA2024C

The TA2024C operates by generating a high frequency switching signal based on the audio input. This signal is sent through a low-pass filter that recovers an amplified version of the audio input. The frequency of the switching pattern is spread spectrum in nature and typically varies between 100kHz and 1MHz, which is well above the 20Hz – 20kHz audio band. The pattern itself does not alter or distort the audio input signal, but it does introduce some inaudible components.

The measurements of certain performance parameters, particularly noise related specifications such as THD+N, are significantly affected by the design of the low-pass filter used on the output as well as the bandwidth setting of the measurement instrument used. Unless the filter has a very sharp roll-off just beyond the audio band or the bandwidth of the measurement instrument is limited, some of the inaudible noise components introduced by the TA2024C amplifier switching pattern will degrade the measurement.

One feature of the TA2024C is that it does not require large multi-pole filters to achieve excellent performance in listening tests, usually a more critical factor than performance measurements. Though using a multi-pole filter may remove high-frequency noise and improve THD+N type measurements (when they are made with wide-bandwidth measuring equipment), these same filters degrade frequency response. The EB-TA2024C Evaluation Board has a simple two-pole output filter with excellent performance in listening tests.

(See Application Note 4 for more information on bench testing with Tripath Class-T amplifiers)

EMI and Shielding

Due to the spread-spectrum nature of the Class-T amplifier (the energy is spread across a wider spectrum, instead of being concentrated at a single frequency), we have found that specific EMI shielding is typically not necessary for most applications where the amplifier board is mounted inside a chassis.

 (See Application Note 11 for more information on EMI)

Contact Information

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For more Sales Information, please visit us @ www.tripath.com/cont_s.htm
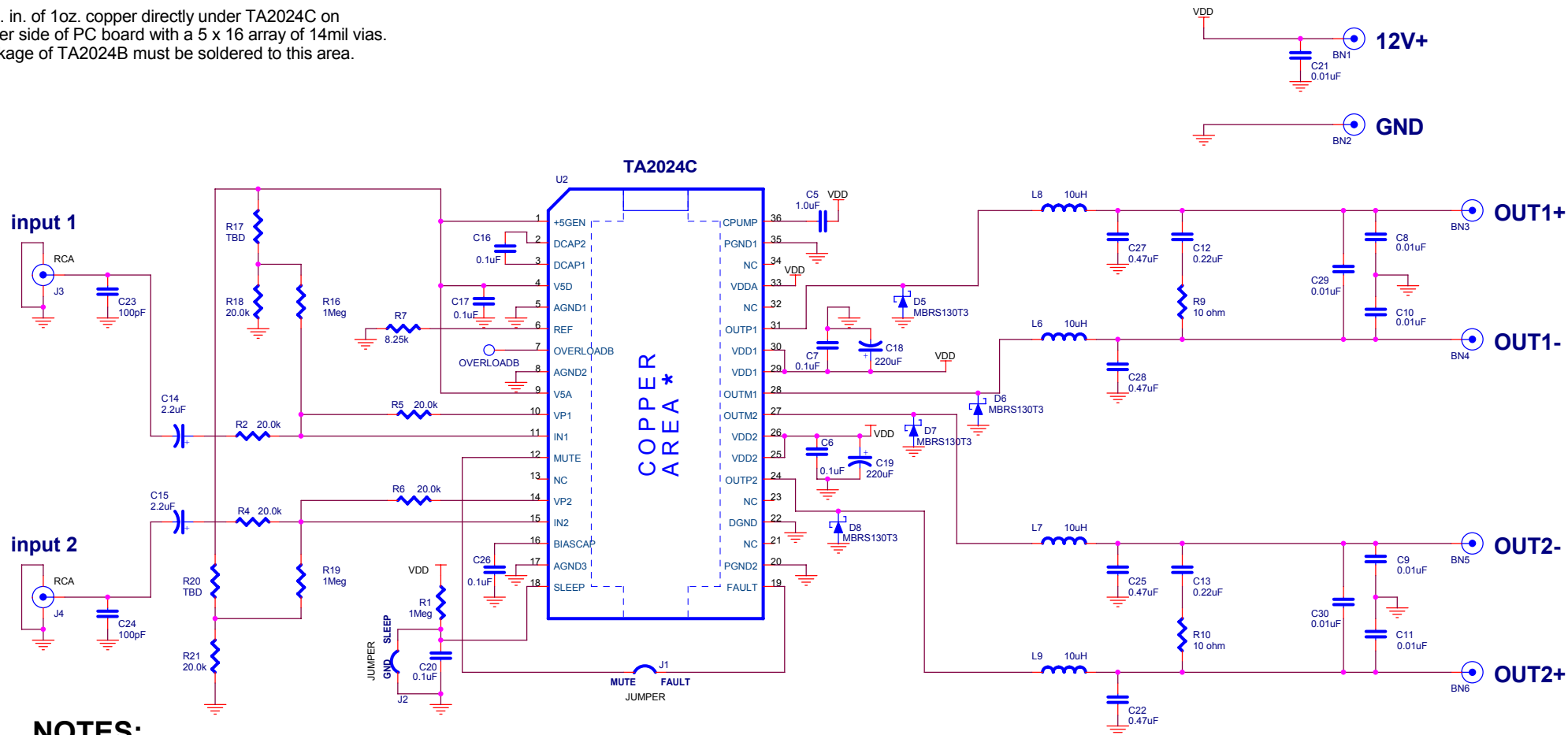For more Technical Information, please visit us @ www.tripath.com/data.htm

EB-TA2024C BOM with Volume Costing

Item	Quantity	Reference	Value	PCB Footprint	Rating	Tolerance	Manufacturer	Manufacturer Part #	Source	Source Part #	unit price	min qty	Price Per Board
1	1	BN1	12V+	BANANA_PLT_A			Johnson Comp.	108-0740-001	Digikey	J147-ND			$0.000
2	1	BN2	GND	BANANA_PLT_A			Johnson Comp.	108-0740-001	Digikey	J147-ND			$0.000
3	1	BN3	OUT1+	BANANA_PLT_A			Johnson Comp.	108-0740-001	Digikey	J147-ND			$0.000
4	1	BN4	OUT1-	BANANA_PLT_A			Johnson Comp.	108-0740-001	Digikey	J147-ND			$0.000
5	1	BN5	OUT2-	BANANA_PLT_A			Johnson Comp.	108-0740-001	Digikey	J147-ND			$0.000
6	1	BN6	OUT2+	BANANA_PLT_A			Johnson Comp.	108-0740-001	Digikey	J147-ND			$0.000
7	1	C5	1.0uF	805	>=16V	X5R	Panasonic	ECJ-2FB1C105K	Digikey	PCC2249TR-ND	$0.035	18k	$0.035
8	6	C6,C7,C16,C17,C20,C26	0.1uF	603	>=16V	X7R	Epcos Inc.	B37931K9104K060	Digikey	B37931K9104K060-ND	$0.004	4k	$0.024
9	6	C8,C9,C10,C11,C29,C30	0.01uF	603	>=16V	X7R	AVX Corp.	06035C103KAT2A	Digikey	478-1227-2-ND	$0.011	24k	$0.066
10	2	C12,C13	0.22uF	805	>=16V	X7R	Epcos Inc.	B37941k9224K60	Digikey	495-1936-2-ND	$0.012	12k	$0.024
11	2	C15,C14	2.2uF	805	10V	X7R	Murata	GRM21BR71A225KA01L	Digikey	490-1696-2-ND	$0.039	24k	$0.078
12	2	C18,C19	220uF	cape\150\300	>=16V	20%	Panasonic	EEU-FM1E221	Panasonic	EEU-FM1E221	$0.045	1k	$0.090
13	1	C21	0.01uF	805	>=16V	X7R	AVX Corp.	06035C103KAT2A	Digikey	478-1227-2-ND	$0.011	24k	$0.011
14	4	C22,C25,C27,C28	0.47uF	805	>=16V	X7R	Epcos Inc.	B37941K9474K60	Digikey	495-1938-2-ND	$0.021	12k	$0.084
15	2	C23,C24	100pF	603	>=16V	X7R	Epcos Inc.	B37931K1101K060	Digikey	B37931K1101K060-ND	$0.005	4k	$0.010
16	4	D5,D6,D7,D8	MBRS130T3	MBRS130T3	30V	1A	On Semi	MBRS130T3	Digikey	MBRS130T3OSTR-ND	$0.069	100k	$0.276
17	1	J1	MUTE FAULT	SIP-2P									$0.000
18	1	J2	GND SLEEP	SIP-2P									$0.000
19	1	J3	input 1	INPUT_RCA					Mouser	161-4214			$0.000
20	1	J4	input 2	INPUT_RCA					Mouser	161-4214			$0.000
21	4	L6,L7,L8,L9	10uH	IND200\400	2A	10%	Toko	822LY-100K (type 8RHB2)	Toko	822LY-100K (type 8RHB2)	$0.069	100k	$0.276
22	3	R1,R16,R19	1Meg	603		5%	Panasonic	ERJ-3GEYJ105V	Digikey	P1.0MGCT-ND	$0.002	500k	$0.006
23	6	R2,R4,R5,R6,R18,R21	20.0k	603		1%	Yageo	RC0603FR-0720KL	Digikey	311-20.0KHRTR-ND	$0.002	500k	$0.012
24	1	R7	8.25k	603		1%	Rohm	MCR03EZPFX8251	Digikey	RHM8.25KHTR-ND	$0.002	500k	$0.002
25	2	R10,R9	10 ohm	1206	1/4W	5%	Panasonic	ERJ-8GEYJ100V	Digikey	P10ETR-ND	$0.005	100k	$0.010
26	1	U2	TA2024C	sta500									
27	1	V1	OVERLOADB	VIA-1P									
28	2	R17,R20	TBD (refer to truth table in TA2024C rev.0.95 Datasheet)	603		1%							

Alternate Low Pass Filter Inductors (L6, L7, L8, L9):

Manufacturer	Part Number	Type	Inductance	Rated DC Current	Notes	COST	MINIMUM QTY	NOTES	CONTACT INFO.
Datatronic	PT21707	same	10uH	1.90Amax	unshielded bobbin inductor	$0.070	100k		Jamie Hopper- (951)-928-7700 x770 OR jamie_hopper@datatronics.com
Toko	822LY-100K	8RHT2	10uH	1.96Amax	unshielded bobbin inductor	$0.090	100k	negotiable pricing	Bob Nau- (619)-656-8966 OR bnau@tokoam.com
Toko	822MY-100K	8RHB2	10uH	1.96Amax	unshielded bobbin inductor				
ISI	RL622-100K	RL622	10uH	3.00Amax	unshielded bobbin inductor				Debbie Hocker-(714)-999-9555 OR debbieh@inductorsupply.com
Toko	A7040HN-100M	8RDY	10uH	2.6Amax	shielded bobbin inductor				
Toko	B992AS-100M	DS86C	10uH	2.9Amax	shielded SMT inductor	$0.160	100k		

4 sq. in. of 1oz. copper directly under TA2024C on
solder side of PC board with a 5 x 16 array of 14mil vias.
Package of TA2024B must be soldered to this area.

VDD

BN1
12V+
C21
0.01uF

GND
BN2

TA2024C

U2

Pin	Name		Name	Pin
1	+5GEN		CPUMP	36
2	DCAP2		PGND1	35
3	DCAP1		NC	34
4	V5D		VDDA	33
5	AGND1		NC	32
6	REF		OUTP1	31
7	OVERLOADB		VDD1	30
8	AGND2		VDD1	29
9	V5A		OUTM1	28
10	VP1		OUTM2	27
11	IN1		VDD2	26
12	MUTE		VDD2	25
13	NC		OUTP2	24
14	VP2		NC	23
15	IN2		DGND	22
16	BIASCAP		NC	21
17	AGND3		PGND2	20
18	SLEEP		FAULT	19

COPPER AREA *

input 1
RCA
J3
C23 100pF

R17 TBD
R18 20.0k
R16 1Meg
R7 8.25k
OVERLOADB
C16 0.1uF
C17 0.1uF
C14 2.2uF
R2 20.0k
R5 20.0k

input 2
RCA
J4
C24 100pF

R20 TBD
R19 1Meg
R21 20.0k
C15 2.2uF
R4 20.0k
R6 20.0k

VDD
R1 1Meg
C26 0.1uF
C20 0.1uF
JUMPER SLEEP GND
J2

MUTE   FAULT
J1
JUMPER

C5 VDD 1.0uF
C7 0.1uF
C18 220uF VDD
C6 0.1uF VDD
C19 220uF
D5 MBRS130T3
D6 MBRS130T3
D7 MBRS130T3
D8 MBRS130T3

L8 10uH
OUT1+
BN3
C27 0.47uF
C12 0.22uF
R9 10 ohm
C29 0.01uF
C8 0.01uF
C10 0.01uF

L6 10uH
OUT1-
BN4
C28 0.47uF

L7 10uH
OUT2-
BN5
C25 0.47uF
C13 0.22uF
R10 10 ohm
C30 0.01uF
C9 0.01uF
C11 0.01uF
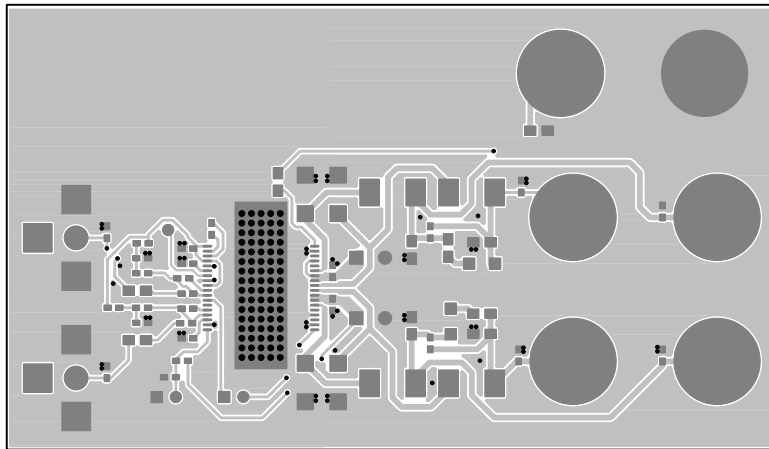
L9 10uH
OUT2+
BN6
C22 0.47uF

NOTES:

1. TA2024C inputs have a DC bias of 2.5V. If input preamp circuitry is NOT biased at
0V, C14 and C15 may need to be reversed.

2. The MUTE function can be optionally tied to the FAULT pin to allow for an automatic
reset in the event of an over current FAULT.

3. For 8 ohm loads .22uF for C22, C25, C27, C28 can be used.

4. Refer to TA2024C datasheet for an explanation of TBD values.
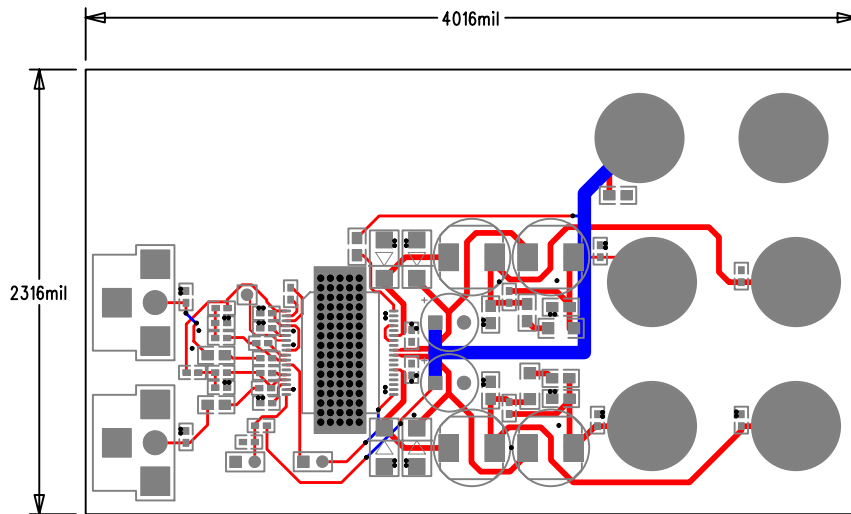
http://www.tripath.com

Tripath Technology, Inc.

Title
TA2024C Evaluation Board

Size B
Document Number
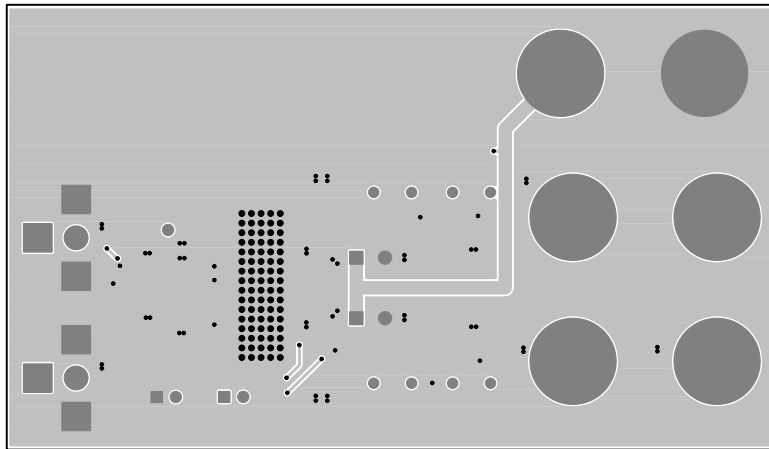Rev 1.1

Date: Monday, October 17, 2005   Sheet 1 of 1

4016mil

2316mil

VIEWED FROM TOP LAYER
COMPOSITE DRAWING
Top Trace RED
Bottom Trace BLUE
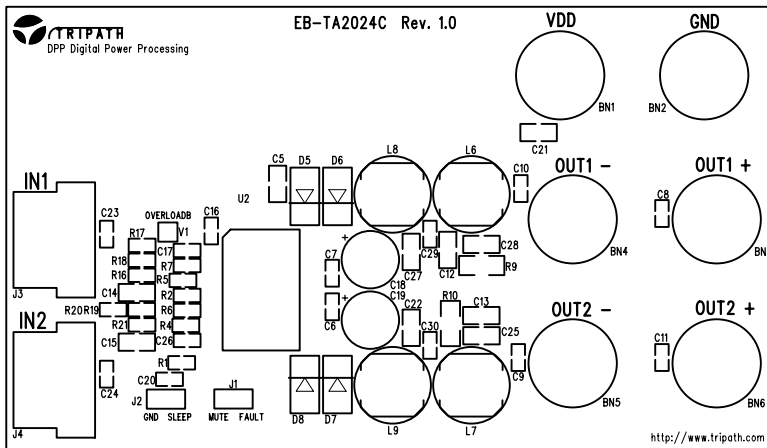Top Component DARK GRAY
Bottom Component LIGHT GRAY

VIEWED FROM TOP LAYER
TOP SIDE ETCH

VIEWED FROM TOP LAYER
BOTTOM SIDE ETCH

TRIPATH
DPP Digital Power Processing

EB-TA2024C Rev. 1.0

VDD

GND

BN1

BN2

C21

IN1

C23

OVERLOADB

C16

U2

C5

D5

D6

L8

L6

C10

OUT1 −

OUT1 +

C8

BN4

BN3

R17

V1

R18

C17

R7

R16

R5

C14

R2

C7

+

C29

C28

C18

C27

C12

R9

J3

R20 R19

R6

C19

C22

R10

C13

IN2

R21

R4

C6

+

C30

C25

C15

C26

OUT2 −

OUT2 +

C20

R1

C9

C11

C24

J2

J1

BN5

BN6

GND   SLEEP
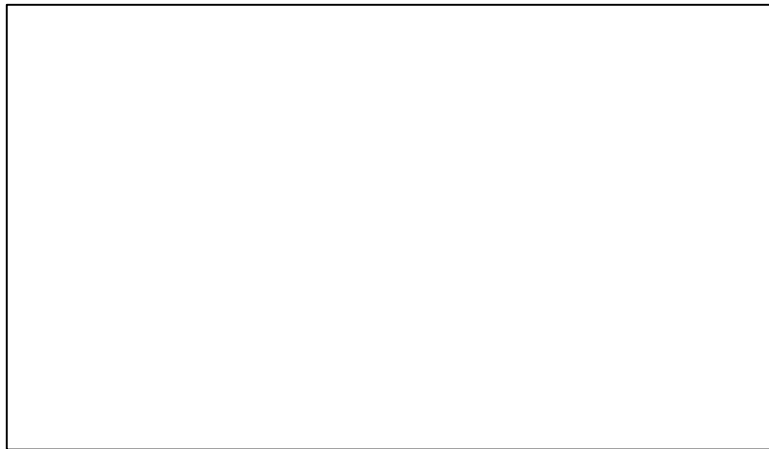
MUTE   FAULT

D8

D7

L9

L7

J4

http://www.tripath.com

FABRICATION NOTES
DOUBLE SIDED BOARD
MATERIAL: .062 FR−4
2 OZ COPPER, ALL LAYERS

VIEWED FROM TOP LAYER
SILKSCREEN TOP

FABRICATION NOTES
DOUBLE SIDED BOARD
MATERIAL: .062 FR-4
2 OZ COPPER, ALL LAYERS

VIEWED FROM TOP LAYER
SILKSCREEN BOTTOM