RB-TA2022

/TRIPATH

CLASS-T DIGITAL AUDIO AMPLIFIER

6 CHANNEL TA2022 REFERENCE DESIGN

GENERAL DESCRIPTION

The RB TA2022 Version 3.1 is a 6 channel, 100W per channel audio amplifier designed to provide a simple and straightforward environment for the evaluation of the TA2022 amplifier. For additional documentation on the TA2022, see the TA2022 Data Sheet.

APPLICATIONS

➢ Mini/Micro Component Systems
➢ Home Theater Receivers
➢ Car stereo trunk amplifiers
➢ Powered DVD Systems

BENEFITS

➢ More power per cubic inch for 100W/Channel design
➢ Simplifies thermal management
➢ Signal Quality comparable to linear amplifiers

FEATURES

➢ High Power: 100W @ 4Ω, 1.0% THD+N
➢ Low Noise Floor: 180uV A-weighted
➢ Low Distortion: .05% THD+N @ 75W, 4Ω
➢ High Efficiency: 92% for 8Ω loads
             87% for 4Ω loads
➢ Dynamic Range = 102dB
➢ Over-Current Protection
➢ Over and Under Voltage Protection
➢ Over Temperature Protection
➢ Single Ended Outputs
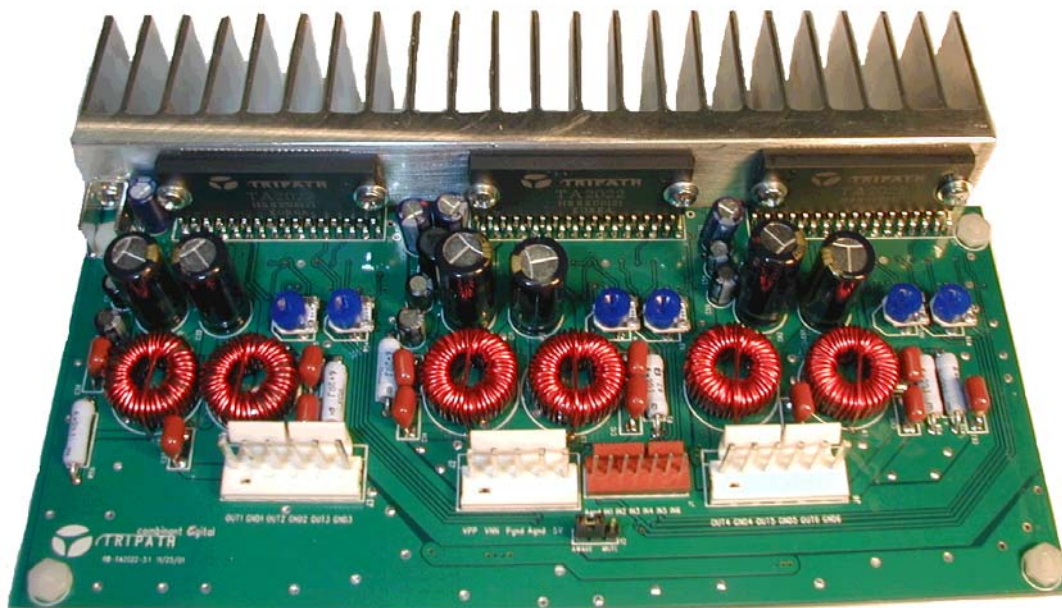
OPERATING INSTRUCTIONS

BOARD CONNECTION DIAGRAM
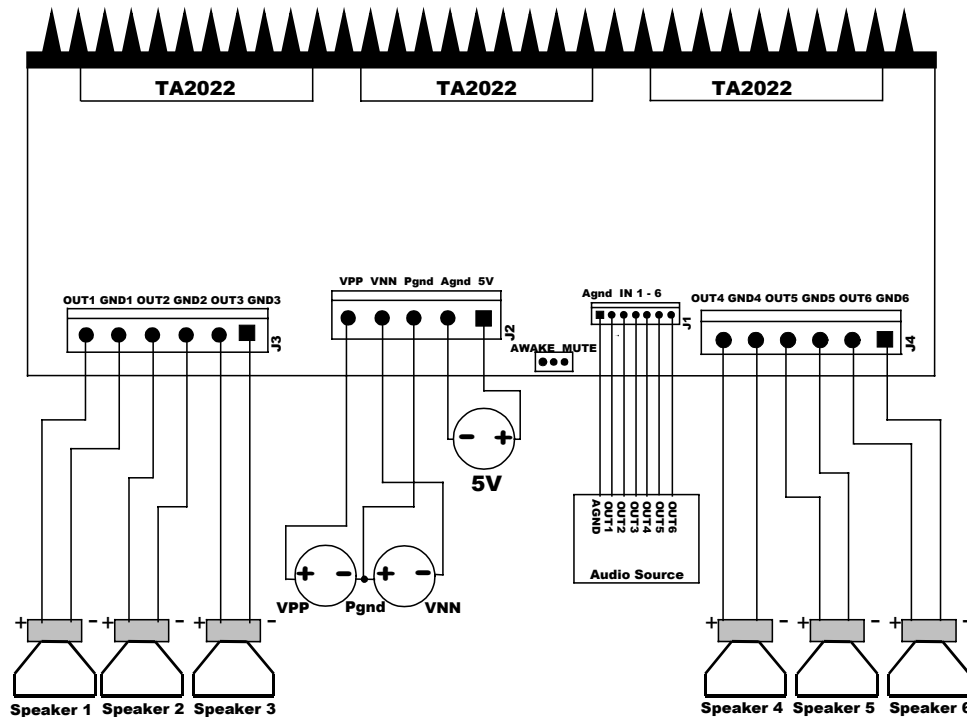
POWER SUPPLIES

Three external power supplies are required to operate the RB-TA2022: VPP, VNN (referenced to Pgnd), and 5V (referenced to Agnd). The VPP and VNN form a split rail supply referenced to Pgnd. The 5V ground (Agnd) must be kept separate from the VPP and VNN ground (Pgnd). Agnd and Pgnd are joined at a common point on the RB-TA2022.

Minimum and Maximum supply voltages are +/-20V and +/-36V, respectively, depending on the load impedance. It is not recommended that the RB-TA2022 be operated above +/-31V when driving 4Ω loads, single ended, as the internal current limit circuit may activate, causing the amplifier to mute.

The VPP and VNN power supply connection, J2, is through a 5-Pin 0.156" spaced header. The female terminal housing for this header is Molex 09-50-8051. Please see TABLE 1 for header connections.

The 5V power supply connection, J2, is through a 5-Pin 0.156" spaced header. The female terminal housing for this header is Molex 09-50-8051. Please see TABLE 1 for header connections.

TABLE 1

J3 Connector Pin#	Connection
Pin1	5V
Pin2	Agnd
Pin3	Pgnd
Pin4	VNN
Pin5	VPP

OUTPUT

The output connection, J3 and J4, is through two 6-Pin 0.156" spaced headers. The female terminal housing for this header is Molex 09-50-8061. The output of the TA2022 is single-ended, therefore each output has a positive output (OUT1) and a ground (GND1). Please see TABLE 2 for header connections.

TABLE 2

J3 Connector Pin#	Connection
Pin1	GND3
Pin2	OUT3
Pin3	GND2
Pin4	OUT2
Pin5	GND1
Pin6	OUT1

J4 Connector Pin#	Connection
Pin1	GND6
Pin2	OUT6
Pin3	GND5
Pin4	OUT5
Pin5	GND4
Pin6	OUT4

I N P U T

The input connection, J1, is through a 7-Pin 0.100" spaced header. The female terminal housing for this header is Molex 22-01-2077. The six inputs share a common ground referenced to Agnd. Please see TABLE 3 for header connections.

TABLE 3

J1 Connector Pin#	Connection
Pin1	Agnd
Pin2	IN1
Pin3	IN2
Pin4	IN3
Pin5	IN4
Pin6	IN5
Pin7	IN6

JUMPER SETTINGS

There is a 3-pin header for the MUTE control of the three TA2022's. With the jumper placed in the AWAKE position the part is un-muted by grounding (AGND) the mute pin. When the jumper is placed in the MUTE position the mute pin is pulled high (5V) and the amplifier is muted.

OUTPUT OFFSET NULL

There is a potentiometer for each channel that is used to manually trim each channels output offset to 0V.

GAIN SETTING

The gain of each channel for the RBTA2022 is set to 18V/V. The gain of the TA2022 is the product of the input stage and the modulator stage. The input stage gain is set to unity. Before changing the gain of the TA2022, please refer to the TA2022 Amplifier Gain section of the TA2022 Data Sheet.
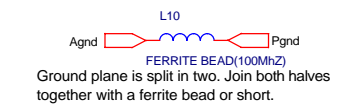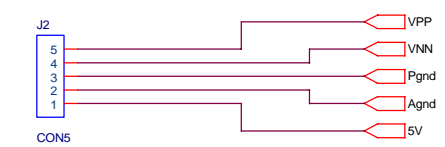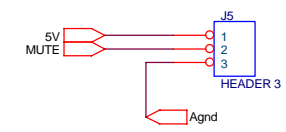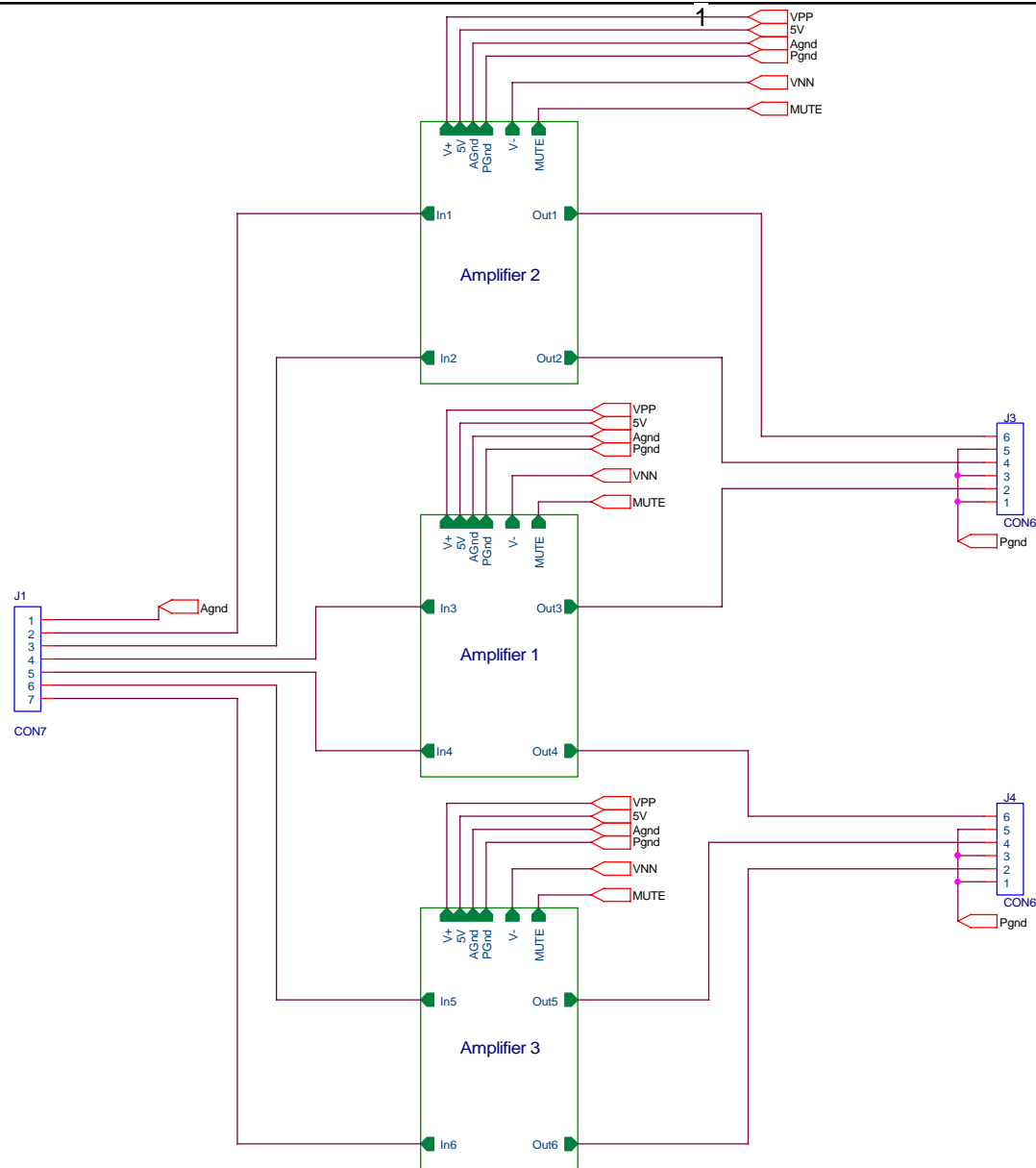
Performing Measurements on the RBTA2022 Version 3.1

The TA2022 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 TA2022 amplifier switching pattern will degrade the measurement by including out of band (audio) energy.

One feature of the TA2022 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 RB-TA2022 has a simple two-pole output filter with excellent performance in listening tests.
(See Application Note 4 for additional information on bench testing)

1

VPP
5V
Agnd
Pgnd
VNN
MUTE

J5
1
2
3
HEADER 3
5V
MUTE
Agnd

V+ 5V AGnd PGnd V- MUTE

In1   Out1

Amplifier 2

In2   Out2

VPP
5V
Agnd
Pgnd
VNN
MUTE

V+ 5V AGnd PGnd V- MUTE

J3
6
5
4
3
2
1
CON6
Pgnd

J2
5
4
3
2
1
CON5

VPP
VNN
Pgnd
Agnd
5V

J1
1
2
3
4
5
6
7
CON7

In3   Out3

Amplifier 1

In4   Out4

Agnd

VPP
5V
Agnd
Pgnd
VNN
MUTE

V+ 5V AGnd PGnd V- MUTE

J4
6
5
4
3
2
1
CON6
Pgnd

In5   Out5

Amplifier 3

In6   Out6

L10
Agnd Pgnd
FERRITE BEAD(100MhZ)
Ground plane is split in two. Join both halves
together with a ferrite bead or short.

1

TA2022-100

tornado_32p_zip_6   U1
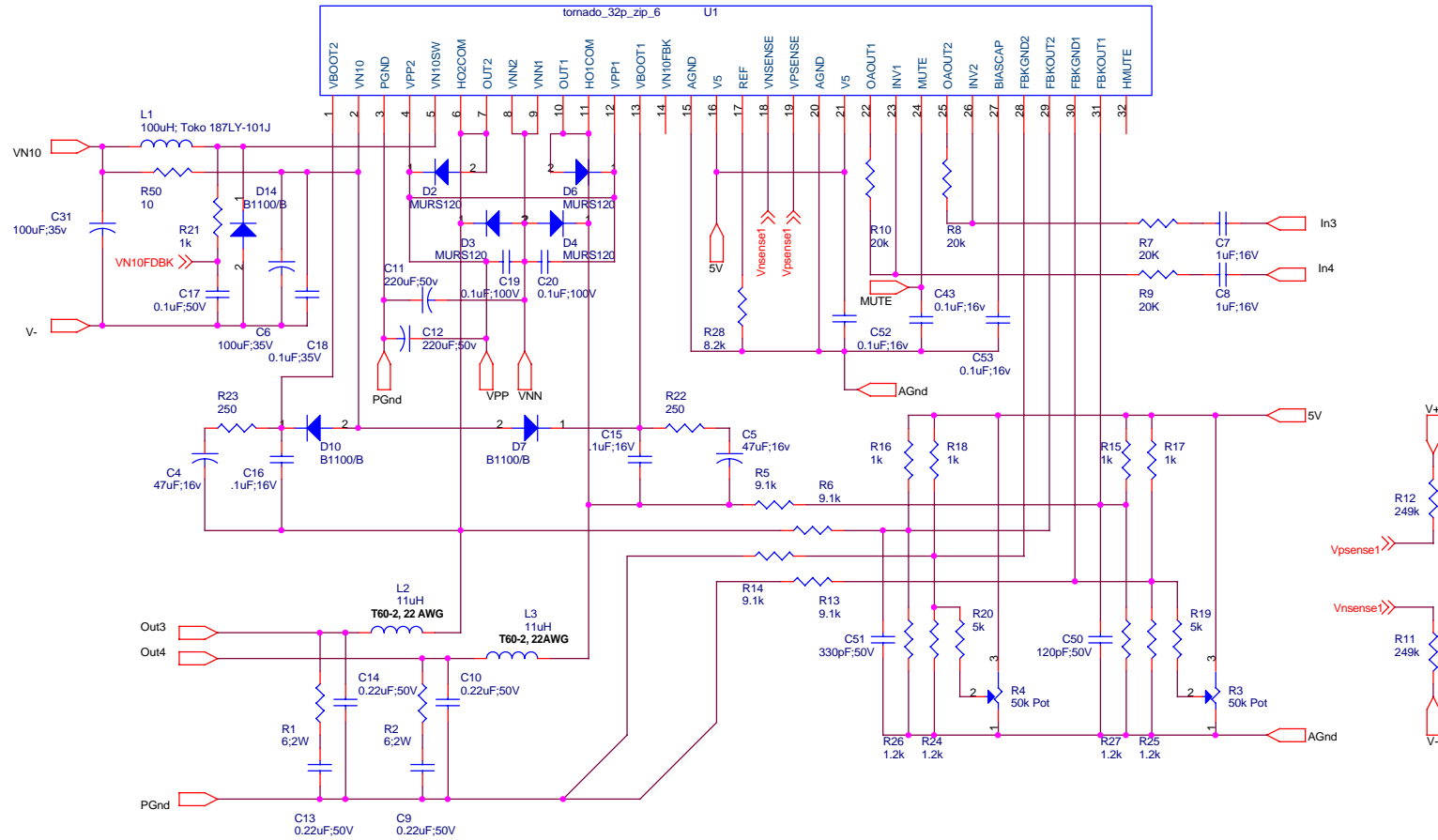
Schematic diagram: 6 Channel TA2022 Demo Board — Amplifier 1

TA2022-100

tornado_32p_zip_6   U2

Pin labels (left to right, 1–32): VBOOT2, VN10, PGND, VPP2, VN10SW, HO2COM, OUT2, VNN2, VNN1, OUT1, HO1COM, VPP1, VBOOT1, VN10FBK, AGND, V5, REF, VNSENSE, VPSENSE, AGND, V5, OAOUT1, INV1, MUTE, OAOUT2, INV2, BIASCAP, FBKGND2, FBKOUT2, FBKGND1, FBKOUT1, HMUTE

R77 10
VN10
V-
C56 0.1uF;35V
C33 100uF;35V

D5 MURS120
D13 MURS120
D12 MURS120
D11 MURS120

C32 220uF;50v
C44 0.1uF;100V
C45 0.1uF;100V
C29 220uF;50v

PGnd
VPP   VNN

R48 250
D8 B1100/B
C27 47uF;16v
C42 .1uF;16V

D9 B1100/B
C41 .1uF;16V
R47 250
C28 47uF;16v

L6 11uH T60-2, 22 AWG
L5 11uH T60-2, 2 AWG

Out1
Out2
C37 0.22uF;50V
C40 0.22uF;50V
R56 6;2W
R57 6;2W
PGnd
C38 0.22uF;50V
C39 0.22uF;50V

5V

Vnsense2
Vpsense2

R43 20k
R44 20k
R42 8.2k

MUTE
C21 0.1uF;16v
C49 0.1uF;16v
C48 0.1uF;16v
AGnd

R51 20K
R32 20K
C36 1uF;16V
C35 1uF;16V
In1
In2

R30 1k
R33 1k
R34 1k
R35 1k
5V

R52 9.1k
R31 9.1k
R37 9.1k
R41 9.1k

C46 100pF;50V
R49 5k
C47 22pF;50V
R53 5k

R55 50k Pot
R54 50k Pot

R36 1.2k R38 1.2k
R39 1.2k R40 1.2k
AGnd

V+
R45 249k
Vpsense2
Vnsense2
R46 249k
V-

TA2022-100

tornado_32p_zip_6   U3

Pin labels (left to right): VBOOT2, VN10, PGND, VPP2, VN10SW, HO2COM, OUT2, VNN2, VNN1, OUT1, HO1COM, VPP1, VBOOT1, VN10FBK, AGND, V5, REF, VNSENSE, VPSENSE, AGND, V5, OAOUT1, INV1, MUTE, OAOUT2, INV2, BIASCAP, FBKGND2, FBKOUT2, FBKGND1, FBKOUT1, HMUTE

VN10

R85
10

C34
0.1uF;35V

V-

C30
100uF;35V

D15
MURS120

D18
MURS120

D16
MURS120

D17
MURS120

C61
220uF;50V

C70
0.1uF;100V

C71
0.1uF;100V

C62
220uF;50V

PGnd

VPP   VNN

5V

R84
8.2k

Vnsense3
Vpsense3

R66
20k

R64
20k

MUTE

C22
0.1uF;16v

C83
0.1uF;16v

C84
0.1uF;16v

AGnd

R63
20K

C57
1uF;16V

In5

R65
20K

C58
1uF;16V

In6

R79
250

R78
250

D20
B1100/B

D19
B1100/B

C65
.1uF;16V

C55
47uF;16V

C54
47uF;16V

C66
.1uF;16V

R61
9.1k

R62
9.1k

R72
1k

R74
1k

R71
1k

R73
1k

5V

V+

R68
249k

Vpsense3

R70
9.1k

R69
9.1k

C82
470pF;50V

R76
5k

C81
180pF;50V

R75
5k

Vnsense3

R67
249k

L8
11uH
T60-2, 22 AWG

L9
11uH
T60-2, 22 AWG

Out5

Out6

C64
0.22uF;50V

C60
0.22uF;50V

R29
6;2W

R58
6;2W

R60
50k Pot

R59
50k Pot

PGnd

C63
0.22uF;50V

C59
0.22uF;50V

R82 R80
1.2k 1.2k

R83 R81
1.2k 1.2k

AGnd

V-

Bill Of Materials

Item	Quantity	Reference	Part	Digikey Part #	Manufacturers Part# (Package)
1	19	C15,C16,C17,C18, C21,C22,C34,C41, C42,C43,C48,C49, C52,C53,C56,C65, C66,C83,C84	0.1uF;50V	PCC1864CT-ND	Panasonic ECJ-2VF1H104Z(SMT 0805)
2	6	C19,C20,C44,C45 C70,C71	0.1uF;100V		AVX 12061C104KAT2A (SMT 1206)
3	1	C47	22pF:50V		(SMT 0805)
4	1	C46	100pF;50V	PCC101CGCT-ND	Panasonic ECJ-2VC1H101J(SMT 0805)
5	1	C51	330pF;50V	PCC331CGCT-ND	PANASONIC ECJ-2VC1H331J(SMT 0805)
6	1	C50	120pF;50V		(SMT 0805)
7	1	C82	470pF;50V		(SMT 0805)
8	1	C81	180pF;50V		(SMT 0805)
9	6	C7,C8,C35,C36 C57,C58	3.3uF;6.3V	PCC1925CT-ND	(SMT 0805)
10	12	C9,C10,C13,C14, C37,C38,C39,C40, C59,C60,C63,C64	0.22uF;50V	P4667-ND	Panasonic ECQ-V1H224JL(Thru-Hole)
11	6	C11,C12,C29,C32 C61,C62	220uF;50V	P10325-ND	Panasonic EEU-FC1H221(Thru-Hole)
12	4	C6,C30,C31,C33	100uF;35V	P5165-ND	Panasonic ECA-1VM101(Thru-Hole)
13	6	C4,C5,C27,C28, C54,C55	47uF;16v	P810-ND	Panasonic ECE-A1CKA470(Thru-Hole)
14	7	D7,D8,D9,D10, D14,D19,D20	B1100/B	B1100DICT-ND	Diodes Incorporated (SMA)
15	12	D2,D3,D4,D5,D6, D11,D12,D13,D15, D16,D17,D18	MURS120T3		MURS120T3 (SMT SMB)
16	2	J3,J4	6-pin,0.156" header		Molex 26-60-4060
17	1	J1	7-pin,0.100" header		Molex 22-23-2071
18	1	J5	3-pin,0.100" header	WM4001-ND	Molex 22-03-2031
19	1	J2	5-pin, .156" header		Molex 26-60-4050
20	1		Screw Terminal	8190K-ND	Keystone 8190
21	1	L1	100uH	4300-ND	JWMiller 6000-101k or Toko 187LY-101J
22	6	L2,L3,L5,L6, L8,L9	11uH		T60-2 Core, 22AWG *See note 1
23	1	L10	Ferrite Bead	P10191CT-ND	100MhZ (SMT 0805)
24	12	R7,R8,R9,R10,R32, R43,R44,R51,R63, R64,R65,R66	20k 1%		(SMT 0805)
25	13	R15,R16,R17,R18, R21,R30,R33,R34, R35,R71,R72,R73, R74	1K		(SMT 0805)
26	12	R24,R25,R26,R27, R36,R38,R39,R40,	1.2K		(SMT 0805)

		R80,R81,R82,R83			
27	6	R3,R4,R54,R55, R59,R60	50k Pot	3306P-503-ND	Bourns 3306P
28	12	R5,R6,R13,R14, R31,R37,R41,R52, R61,R62,R69,R70	9.1K,1%		(SMT 0805)
29	6	R1,R2,R29,R56, R57,R58	6;2W	P6.2W-2BK-ND	(2W Thru-hole)
30	6	R11,R12,R45,R46 R67,R68	249K,1%		(SMT 0805)
31	3	R28,R42,R84	8.2K,1%		(SMT 0805)
32	6	R22,R23,R47,R48, R78,R79	249		(SMT 0805)
33	6	R19,R20,R49,R53, R75,R76	5K		(SMT 0805)
34	6	R50,R77,R85	10		(SMT 0805)
35	3	U1,U2,U3	tornado_32p_zip_6		Tripath Technology
36	2		3/8"STANDOFF	4801K-ND	
37	2		STANDOFF NUT	H616-ND	
38	1		1/4" 4-40	H342-ND	
39	6		NO. 4 FLAT	H734-ND	
40	6		3/8" 4-40	H781-ND	

Note 1: Inductor selection is critical for optimal operation of the TA2022 as well as being an important
        component in over current protection and EMI containment. Tripath recommends the customer use a
        toroidal inductor for all applications with the TA2022. This board uses the T60-2(15.2mm outer diameter)
        core which was selected for multi-channel applications. For higher power applications or high ambient
        conditions we recommend the Micrometals T68-2 core or the American Cores (Amidon) T690-06. These cores
        have a high peak current capability due to its low-μ Carbonyl-E metal powder. A distributed air gap
        increases its' energy storage capability, which allows for a small footprint and high current capability.
        The T68-2 and T690-06 cores have a 17.5mm outer diameter. Forty-four turns of 22AWG wire makes
        a complete single layer winding around the toroid with six to eight layers overlapping yielding
        an ideal value of 11uH. This winding pattern, which covers the core completely, aids in
        shielding the electric field. It should be noted that when multiple layers are used there may be
        an increase in winding capacitance, which can cause ringing and increased radiated emmisions.
        Winding techniques, such as bank winding, can minimize this effect. It is important that the
        innitial windings not be crossed over by the last few windings. If a few windings more than
        the single layer are required it is best to wind the core with a full single layer, back off a
        number of turns,and rewind over the last few windings. A larger diameter Carbonyl-E core
        may be used if a single layer wound core is required. If a smaller core is required, a T60-2B/60(15.2mm)
        outer diameter Carbonyl-E core may be substituted, though thermal requirements must be considered. This
        core is wider than the T60-2 core and has the same outer diameter.
        Please contact Tripath Applications if there are questions pertaining to this subject.
  Substitution Notes:
    1- ITEM#2- This component must be .1uF, 100V with X7R material characteristic and placed closely
            to pins 4,8 and 9,10 of TA2022 with less than 1/8" lead length to the part.
    2- ITEM#11- This component should be a high frequency,low ESR capacitor. We recommend .1 ohm,
            or less and a ripple current rating of at least 1A.
    3- ITEM#22- This component should be a 10A inductor with very high linearity.
    4- ITEM#15- This component should be an ultra-fast PN junction rectifier diode with a maximum
             Vf of 1V at 10A.
    5- ITEM#14- The Bootstrap Diodes(D7, D8, D9, D10, D19, D20) should be a Schottky diode rated at
             least 200mA,100V,50nS.
            The VN10 Diode (D14) should be a Fast Recovery, switching, or Shottky diode rated
             at least 200mA,30V,50nS.

TOP SIDE

3121Mils

VIEWED FROM TOP SIDE

7090Mils

BOTTOM SIDE

VIEWED FROM TOP SIDE

3121Mils

7090Mils