



EB-TK2150-1

EB-TK2150-2

CLASS-T DIGITAL AUDIO AMPLIFIER 2 CHANNEL TK2150 EVALUATION BOARD

Technical Information – Board Rev. 1.0

Revision 1.0 – November 2002

GENERAL DESCRIPTION

The EB-TK2150 is a stereo evaluation board based on the TK2150 digital audio power amplifier chipset from Tripath Technology. This board is designed to provide a simple and straightforward environment for the evaluation of the TK2150 amplifier driver. For additional documentation on the TK2150, see the TK2150 Data Sheet.

NOTE: There are two versions of the EB-TK2150, depending on nominal supply voltage.

EB-TK2150-1 – Nominal supply voltage +/-29V to +/-45V

EB-TK2150-2 – Nominal supply voltage +/-39V to +/-60V

APPLICATIONS

- 4Ω and 6 Ω stereo
- 8 Ω mono (Bridged Operation)
- Home Theater Receivers
- Multi-channel Distribution
- Powered DVD Systems
- Mini/Micro Systems

BENEFITS

- Single Ended Outputs
- Simplifies thermal management
- Signal Quality comparable to high quality, linear amplifiers
- Simple building block for multi-channel design

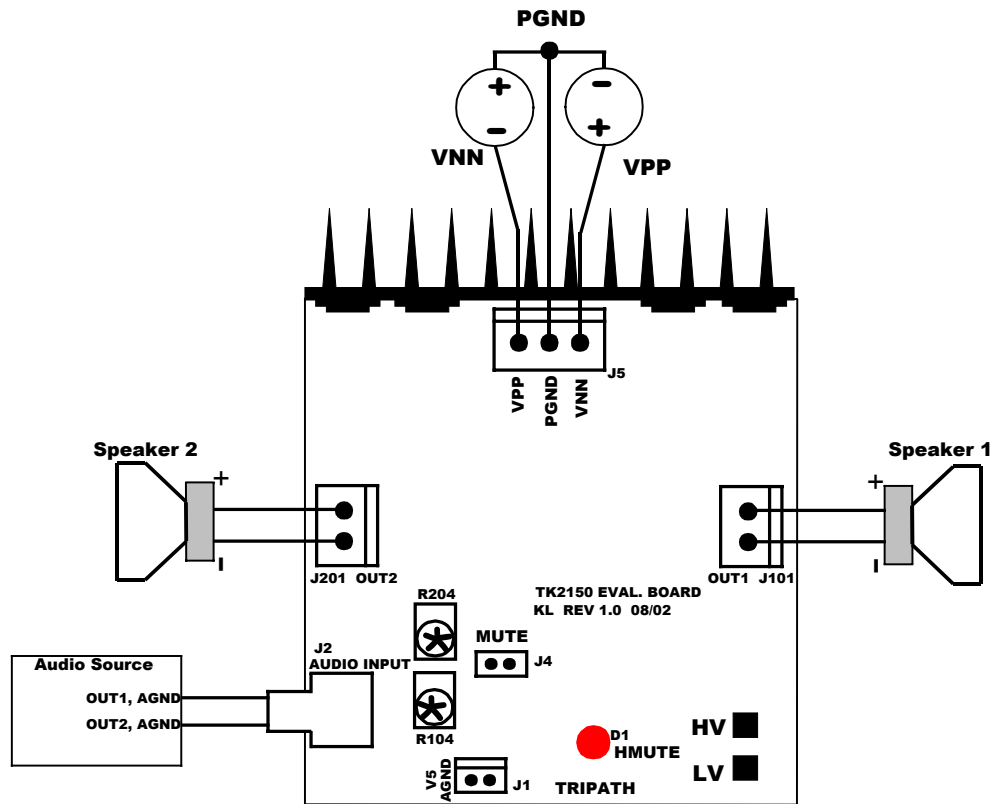
FEATURES

- Low Noise Floor: <165uV A-Weighted *
<250uV A-Weighted**
 - Low Distortion:
.016% THD+N, 100W, 4Ω *
.021% THD+N, 200W, 4Ω **
 - High Efficiency:
92.4% @ 155W, 6Ω *
94.5% @ 294W, 6Ω **
 - Over-Current Protection
 - Over and Under Voltage Protection
 - Over Temperature Protection
- * (+/-45V Supply Voltage)
** (+/-54V Supply Voltage)



OPERATING INSTRUCTIONS

BOARD CONNECTION DIAGRAM



POWER SUPPLIES

Three external power supplies are required to operate the EB-TK2150: VPP (referenced to PGND), VNN (referenced to PGND) and V5 (referenced to AGND). The V5 ground (AGND) must be kept separate from the VPP and VNN ground (PGND). PGND and AGND are joined at a common point on the EB-TK2150 with a ferrite bead (L1).

There are two versions of the EB-TK2150. The “-1” or “LV” (low voltage) version operates from +/-29V to +/-45V, with +/-40V being the nominal supply voltage. The “-2” or “HV” (high voltage) version operates from +/- 39V to +/-60V with +/-54V being the nominal supply voltage. Operation outside these set minimum and maximum supply voltages will cause the TC2001 to shut off the output stages of the amplifiers. The removal of the under-voltage or over-voltage condition returns the TK2150 to normal operation. Please see the Over- and Under- Voltage Protection section of the TK2150 Data Sheet for a more detailed discussion of the rail supply range.

The V5 supply voltage is 5V and should be well regulated. Please see the TK2150 Data Sheet for minimum and maximum values.

The VPP and VNN power supply connection is made with a standard .156” Molex header (J5). The V5 connection is made with a standard .100” Molex header (J1). Please refer to the Board Connection Diagram for the header locations on the EB-TK2150 and the attached Bill-Of-Materials for the header part numbers.

The TP2150 has an internal hysteretic buck converter, which, in conjunction with a few components supply the VN10 voltage required by the TP2150 MOSFET Driver. These external components include a P-Channel FET, 100uF inductor, ultra-fast recovery rectifier diode, and a few passive resistors and capacitors. The diode may be replaced with a Schottky diode rated at least 200mA, 50nS and appropriately voltage rated.

OUTPUT

The output connections for each channel of the EB-TK2150 are made with standard .156" Molex headers (J101, J201). The output of the TK2150 is single-ended; therefore each output has a signal output and a ground output.

Please refer to the Board Connection Diagram for the header locations and speaker connection polarity on the EB-TK2150.

BRIDGED OUTPUT

The EB-TK2150 can be run into bridged six or eight ohm loads. To operate in bridged mode, input equal magnitude but out of phase signals to IN1 and IN2. The output will then be derived from the "+" outputs located at J101 and J201.

It should be noted that operating in bridged mode can theoretically increase the available output power by four times. But this extra output power also results in increased power dissipation for the output fets. If continuous output tests are required, additional heat-sinking may be required. Alternatively, the supply voltage of amplifier can be reduced to a level that produces 2.5-3 times the single ended power. A safe maximum operating supply voltage for the -1 board (with 6 ohm bridged load) would be +/-36V and for the -2 board (with 6 ohm bridged load) would be +/-50V.

The TK2150 can be used for 4 ohm bridged operation (or below), but in most cases this will require using a lower supply voltage, due to increased power dissipation. For the FQP19N10 fets used on the -1 board, +/-28V is a safe voltage for operation assuming 4 ohm bridged load. For the FQP2572 fets used on the -2 board, +/-40V is a safe voltage level for 4 ohm bridged load. These recommended supply voltages are below the levels of the "stock" -1 and -2 boards. To operate at these voltage levels the over/under voltage and feedback resistors will need to be changed. Please refer to the TK2150 data sheet for additional information on selection of external components or contact Tripath directly.

INPUT

The input connection for each channel of the EB-TK2150 is made using a dual RCA connector (female). The dual RCA connector is labeled AUDIO INPUT (J2). The red RCA is the input to CH1 and the white RCA is the input to CH2. These inputs share a common ground referenced to AGND. Please refer to the Board Connection Diagram for the connector locations on the EB-TK2150.

JUMPER SETTINGS

There is a 2-pin header for the MUTE (J4) control of the TK2150. With the jumper in place the part is unmuted. When the jumper is removed the mute pin is pulled high (5V) and the amplifier is muted. Please refer to the Board Connection Diagram for the connector locations on the EB-TK2150. To minimize turn on/off pops, place the amplifier in mute while bringing up/turning off the power supplies.

INDICATOR LED'S

The EB-TK2150 has a red LED (D1) labeled HMUTE. The HMUTE LED will glow red and both outputs are muted when a fault occurs or the MUTE jumper is removed. The most likely causes for a fault are over-current, over-voltage or under-voltage. Please refer to the TK2150 Data Sheet for a complete description of HMUTE. Please refer to the Board Connection Diagram for the LED location on the EB-TK2150.

OUTPUT OFFSET NULL

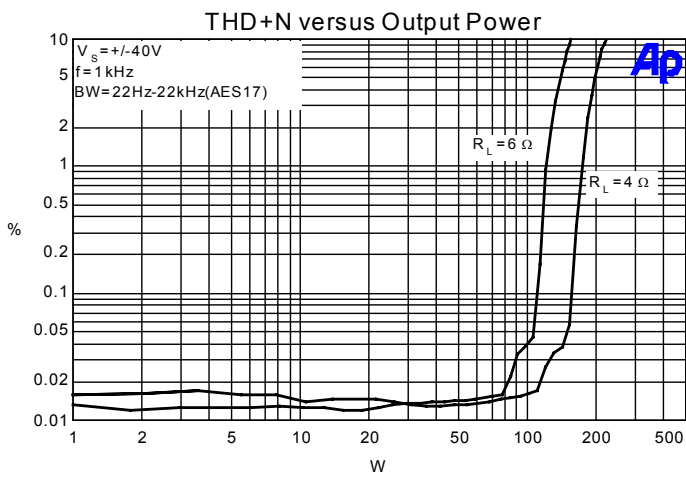
There are two potentiometers, R104 (Channel 1) and R204 (Channel 2) that are used to manually trim the output offsets to 0Vdc. Please refer to the Board Connection Diagram for the potentiometer locations on the EB-TK2150. The evaluation board is shipped with any offsets nulled within +/-10mV.

GAIN SETTING

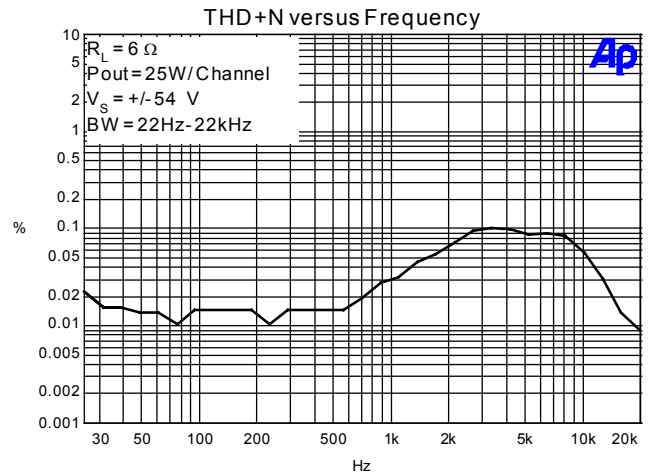
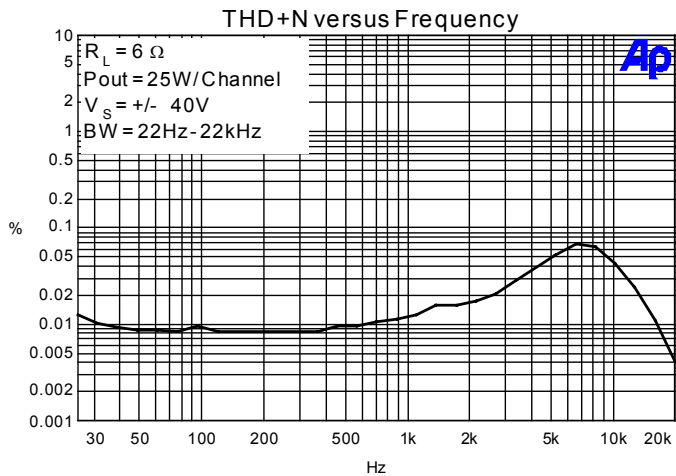
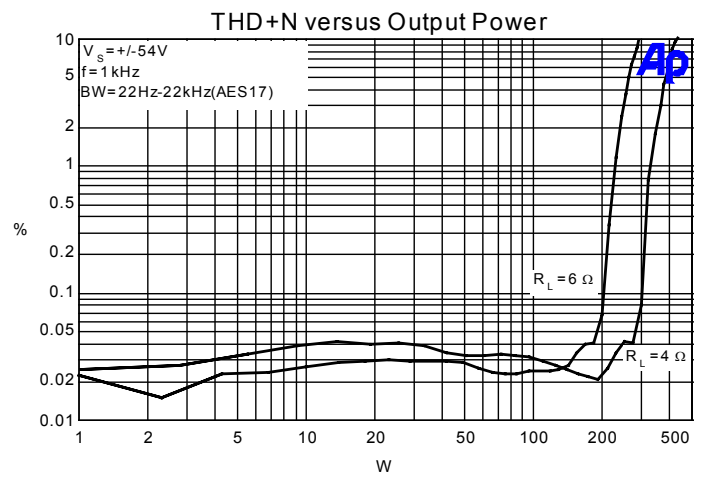
The gain of the EB-TK2150-1 is set to 13.3V/V. The gain of the EB-TK2150-2 is set to 19.95V/V. The gain of the TK2150 is the product of the TC2001 (control stage) gain and the TP2150 (power stage) gain. The control stage gain is set to .664V/V. The TP2150 (power stage) gain is determined from the maximum allowable feedback level for the modulator. Once the designer chooses the maximum supply voltages the feedback level can be optimized and the power stage gain is set. From this point any minor gain adjustments can be made at the control stage. Before changing the gain of the EB-TK2150, please refer to the Amplifier Gain section of the EB-TK2150 Data Sheet.

TYPICAL PERFORMANCE

EB-TK2150-1

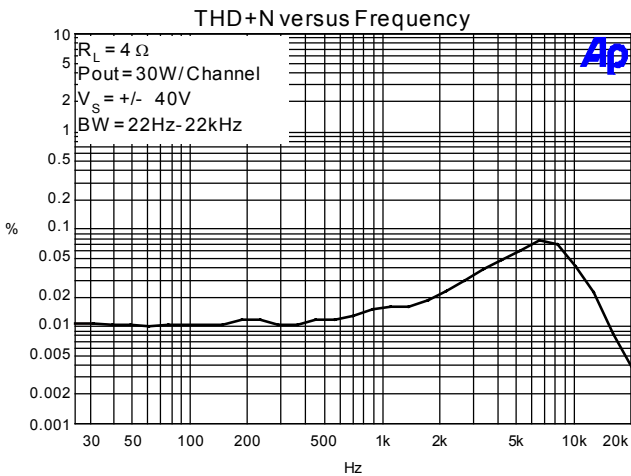


EB-TK2150-2

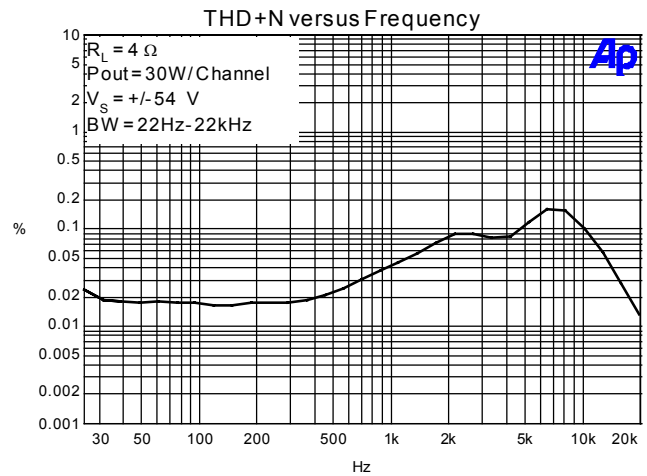


TYPICAL PERFORMANCE

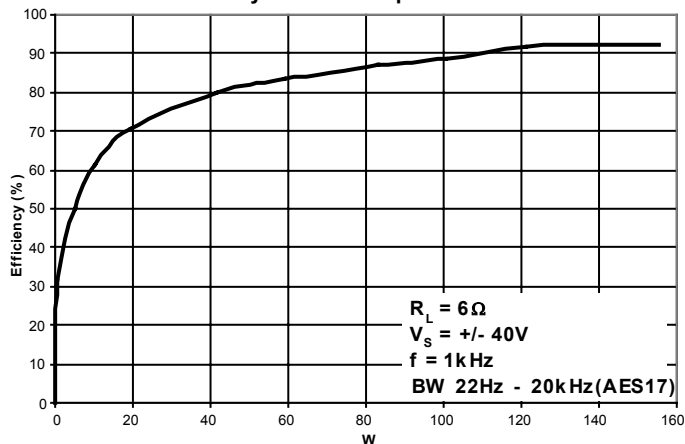
EB-TK2150-1



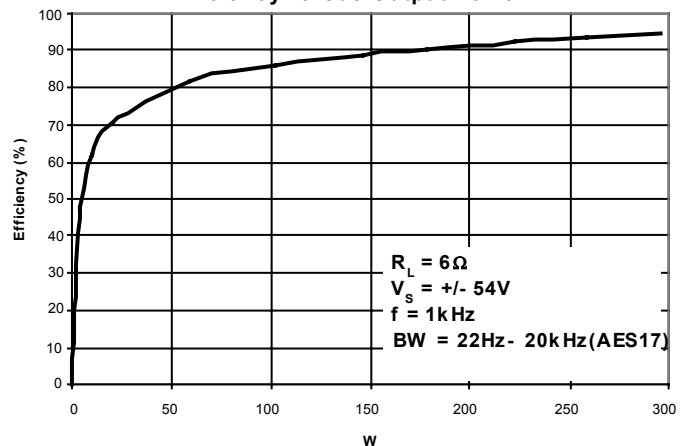
EB-TK2150-2



Efficiency versus Output Power



Efficiency versus Output Power



PERFORMING MEASUREMENTS ON THE EB-TK2150

The TK2150 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 TK2150 amplifier switching pattern will degrade the measurement by including out of band (audio) energy.

One feature of the TK2150 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-TK2150 has a simple two-pole output filter with excellent performance in listening tests. (See Application Note 4 for additional information on bench testing)

Design Files

Soft copy design files in Protel 2.8 format as well as gerber files with embedded apertures are available upon request.

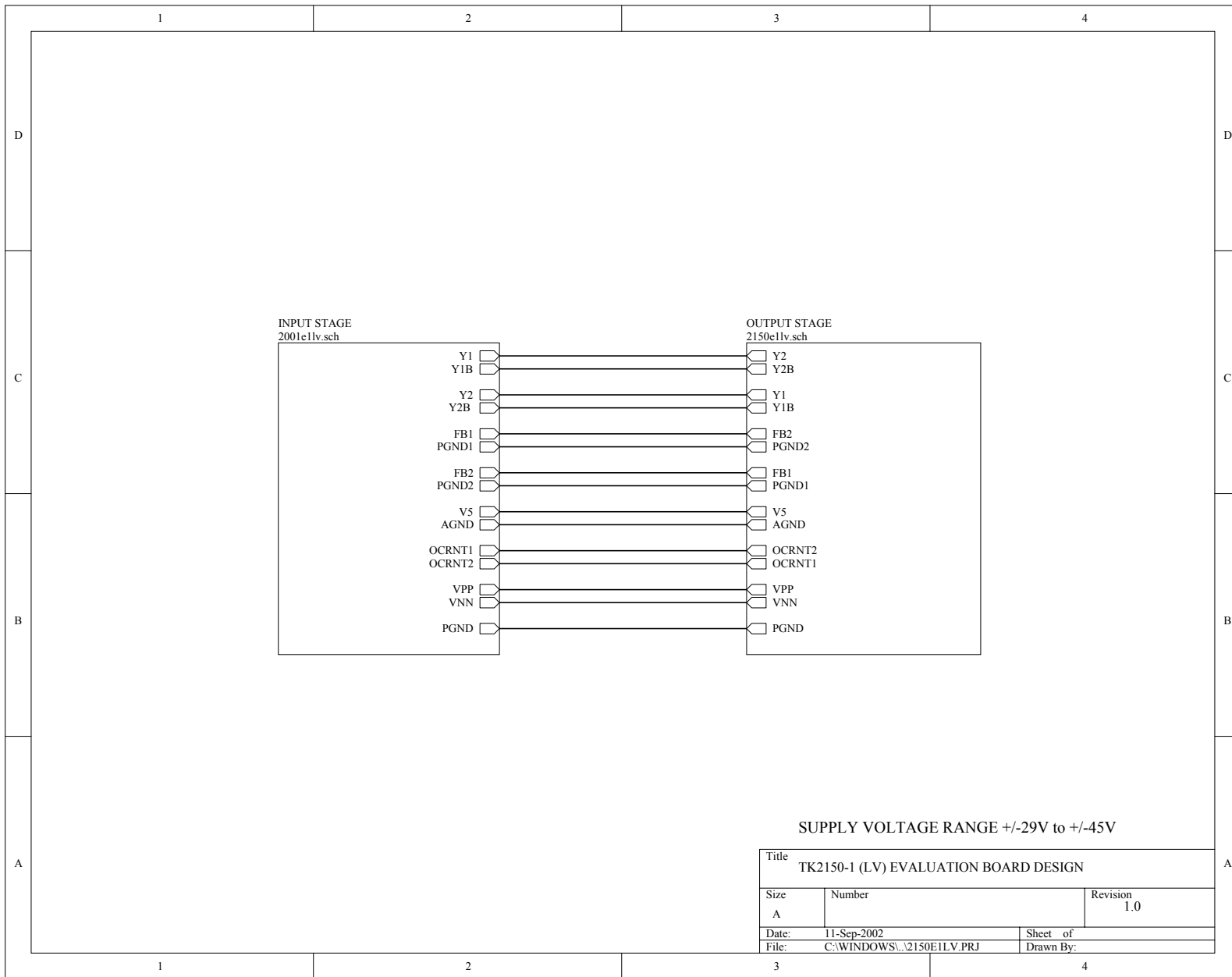
Contact Information

TRIPATH TECHNOLOGY, INC

2560 Orchard Parkway, San Jose, CA 95131
408.750.3000 - P
408.750.3001 - F

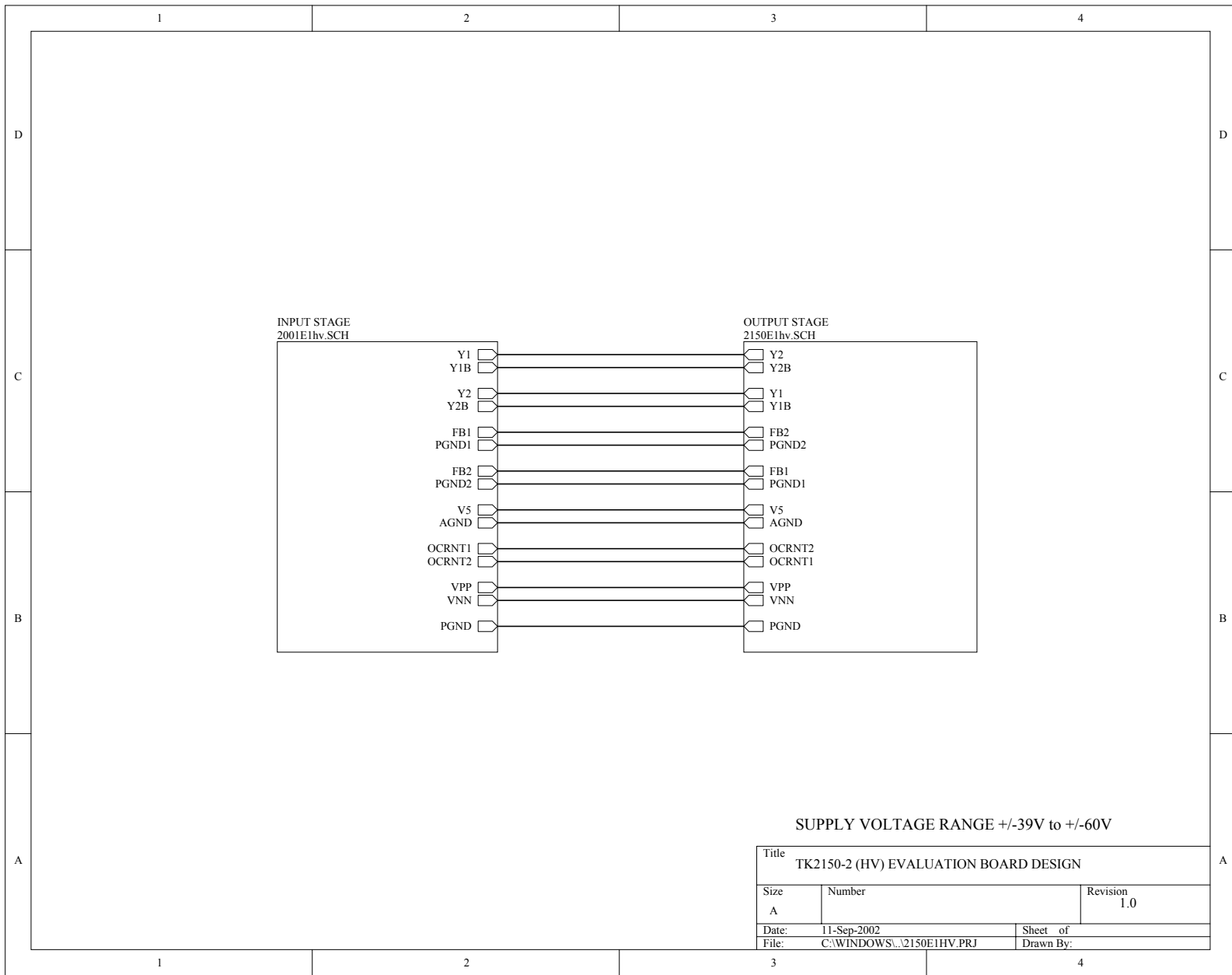
For more Sales Information, please visit us @ www.tripath.com/cont_s.htm

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



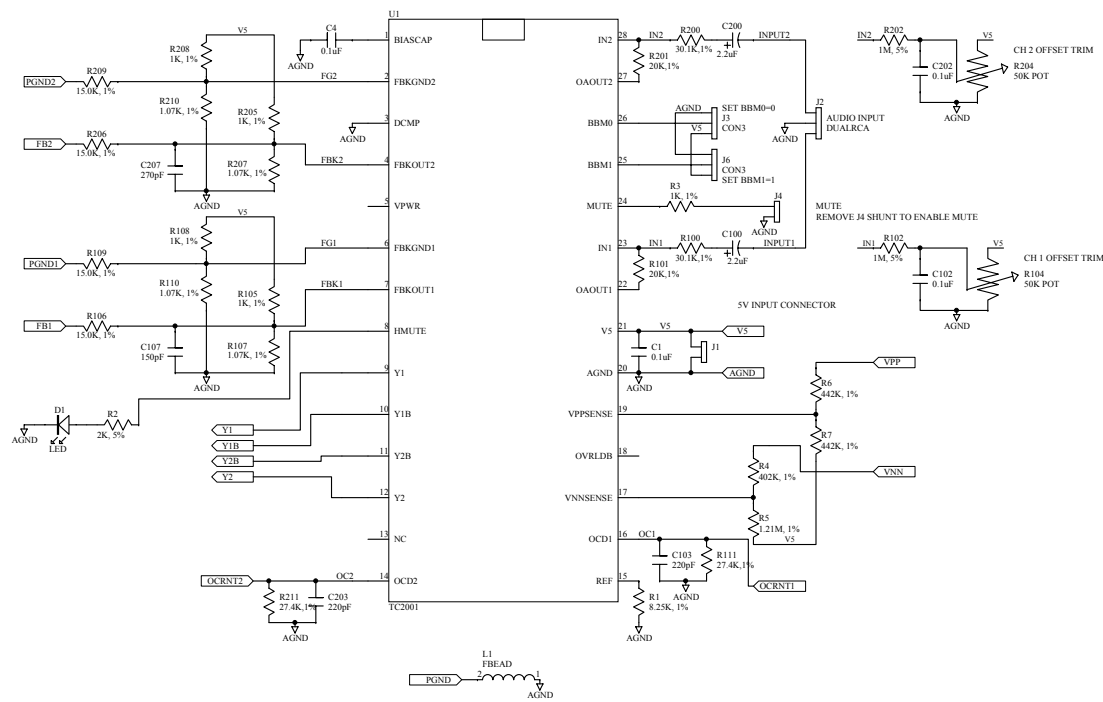
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Used	Part Type	Designator	Footprint	Part Field 1	Part Field 2	Part Field 3
1	0 OHM	R10	0805	*	*	*
4	0.01OHM/1W	R115 R116 R215 R216	RLVR1RG2	VISHAY	WSL2512R0100FTA	MSR 71-WSL2512-0.01
4	0.15uF/100V	C108 C109 C208 C209	C0U22PL10	PANASONIC	ECQ-V1154JM	DK P4727-ND
12	0.1uF	C1 C102 C11 C111 C112 C2 C202 C211 C212 C3 C4 C5	0805	20% TOL.	*	*
4	0.1uF/100V/X7R	C105 C205 C8 C9	1210	KEMET	C1210C104K1RACTU	DK 399-1268-1-ND
4	1.10K, 1%	R107 R110 R207 R210	0805	*	*	*
1	10 OHM, 5%	R8	0805	*	*	*
4	10.0K, 1%	R106 R109 R206 R209	0805	*	*	*
1	100uF/25V	C10	C10UEL05	PANASONIC	ECA-1EHG101	DK P5540-ND
1	100uH/0.5A	L2	IND1UH	TOKO	187LY-101J	DK TK4300-ND
1	150pF	C107	0805	NPO 5%	*	*
2	18uH	L100 L200	T80	AMIDON INDUCTIVE	AW800-06-57T-24-V	T80--2 CORE 57TURNS / 24AWG
6	1K, 1%	R105 R108 R205 R208 R3 R9	0805	*	*	*
2	1M, 5%	R102 R202	0805	*	*	*
2	2.2uF	C100 C200	C10UEL05	PANASONIC	ECA-1HHG2R2	DK P5564-ND
2	20K, 1%	R101 R201	0805	*	*	*
2	200HM/2W	R117 R217	PWR2W	PANASONIC	ERG-2SJ200	DK P20W-2BK-ND
2	220pF	C103 C203	0805	NPO 5%	*	*
2	220uF/50V	C6 C7	C100UEL06	PANASONIC	EEU-FC1H221	DK P10325-ND
2	240 OHM, 5%	R112 R212	0805	*	*	*
1	270pF	C207	0805	NPO 5%	*	*
1	2K, 5%	R2	0805	*	*	*
4	30.1K, 1%	R100 R111 R200 R211	0805	*	*	*
1	301K, 1%	R4	0805	*	*	*
4	33.2OHM/0.5W	R113 R114 R213 R214	2010	PANASONIC	ERJ-12SF33R2U	DK P33.2ACCT-ND
2	332K, 1%	R6 R7	0805	*	*	*
2	33uF/100V	C113 C213	C100UEL06	PANASONIC	EEU-FC2A330	DK P10771-ND
2	47uF/25V	C104 C204	C10UEL05	PANASONIC	ECA-1EHG470	DK P5539-ND
2	50K POT	R104 R204	POTSTURN	BOURNS	3306P-1-103	DK 3306P-103-ND
1	8.25K, 1%	R1	0805	*	*	*
1	909K, 1%	R5	0805	*	*	*
4	AL02 SPACER	SPCR100 SPCR101 SPCR200 SPCR201	TO220SPACER	AAVID THERMALLOY	4170	*
2	CON2	J101 J201	PWR2	WALDOM	26-60-4020	DK WM4620-ND
1	CON2LPWR	J1	CON2B	WALDOM	22-23-2021	DK WM4200-ND
2	CON3	J3 J6	0805JMPR	*	*	*
1	DUALRCA	J2	DUALRCAVERT	CUI INC.	RCJ-2223	DK CP-1435-ND
1	FBEAD	L1	2010	*	*	*
4	FQP13N10	M100 M101 M200 M201	TO220	FAIRCHILD SEMI	FQP13N10	*
1	HDR2	J4	GJMPR001	*	*	*
1	IRF9520NS	Q2	D2PAK2	INTERNATIONAL RECT.	IRF9520NS	DK IRF9520NS-ND
1	LED	D1	LED1	RED LED	*	*
11	MURS120T3	D102 D103 D104 D105 D106 D2 D202 D203 D204 D205 D206	SMB	ON SEMICONDUCTOR	MURS120T3	NWK 08F2006
1	PWRCON3	J5	CON3	WALDOM	26-60-4030	DK WM4621-ND
1	TC2001	U1	SOP28	TRIPATH TECHNOLOGY	*	*
1	TP2150	U2	LQFP64	TRIPATH TECHNOLOGY	*	*
2	WIRE JMPR	JMPR100 JMPR200	JMPR200	14 AWG WIRE		

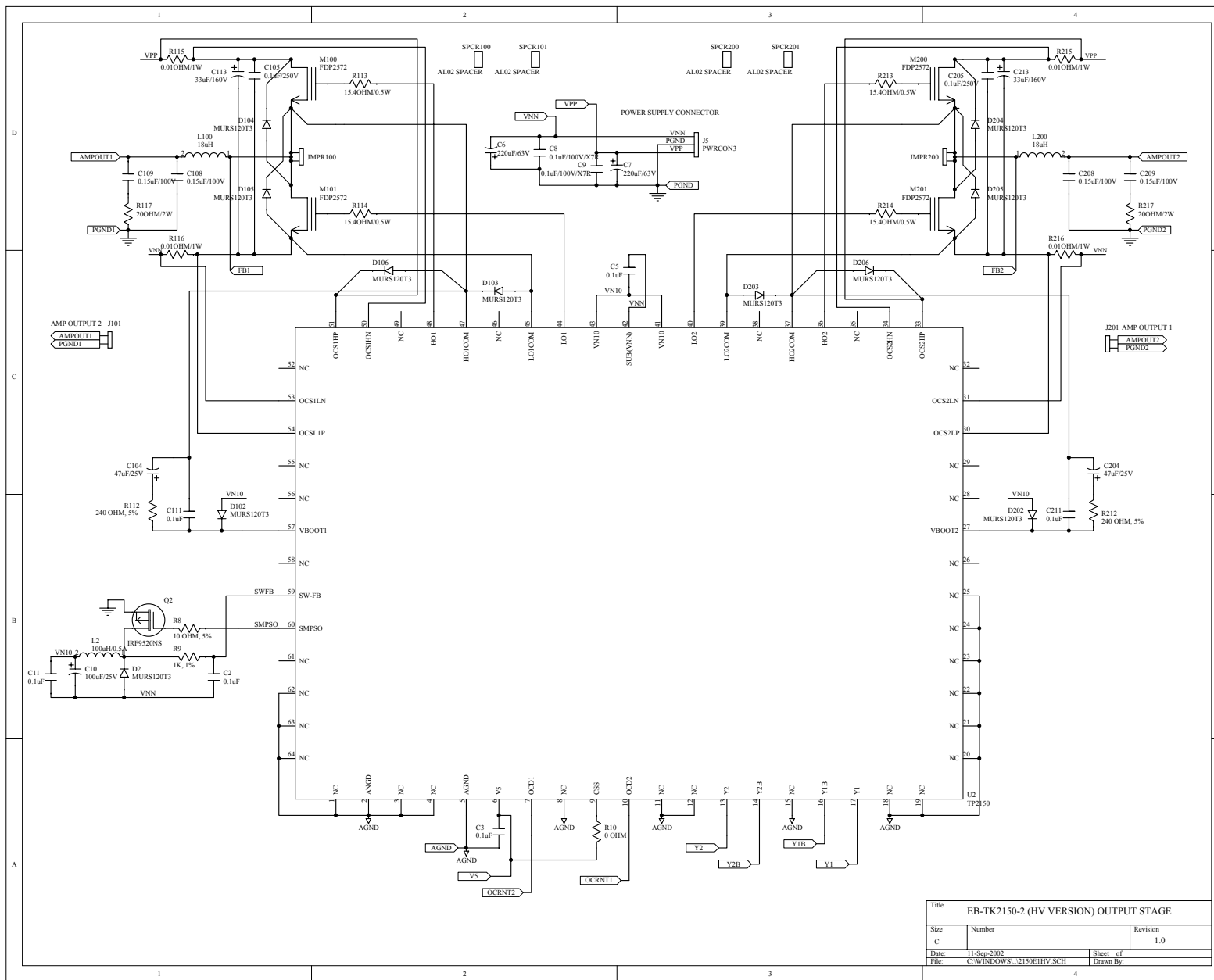


SUPPLY VOLTAGE RANGE +/-39V to +/-60V

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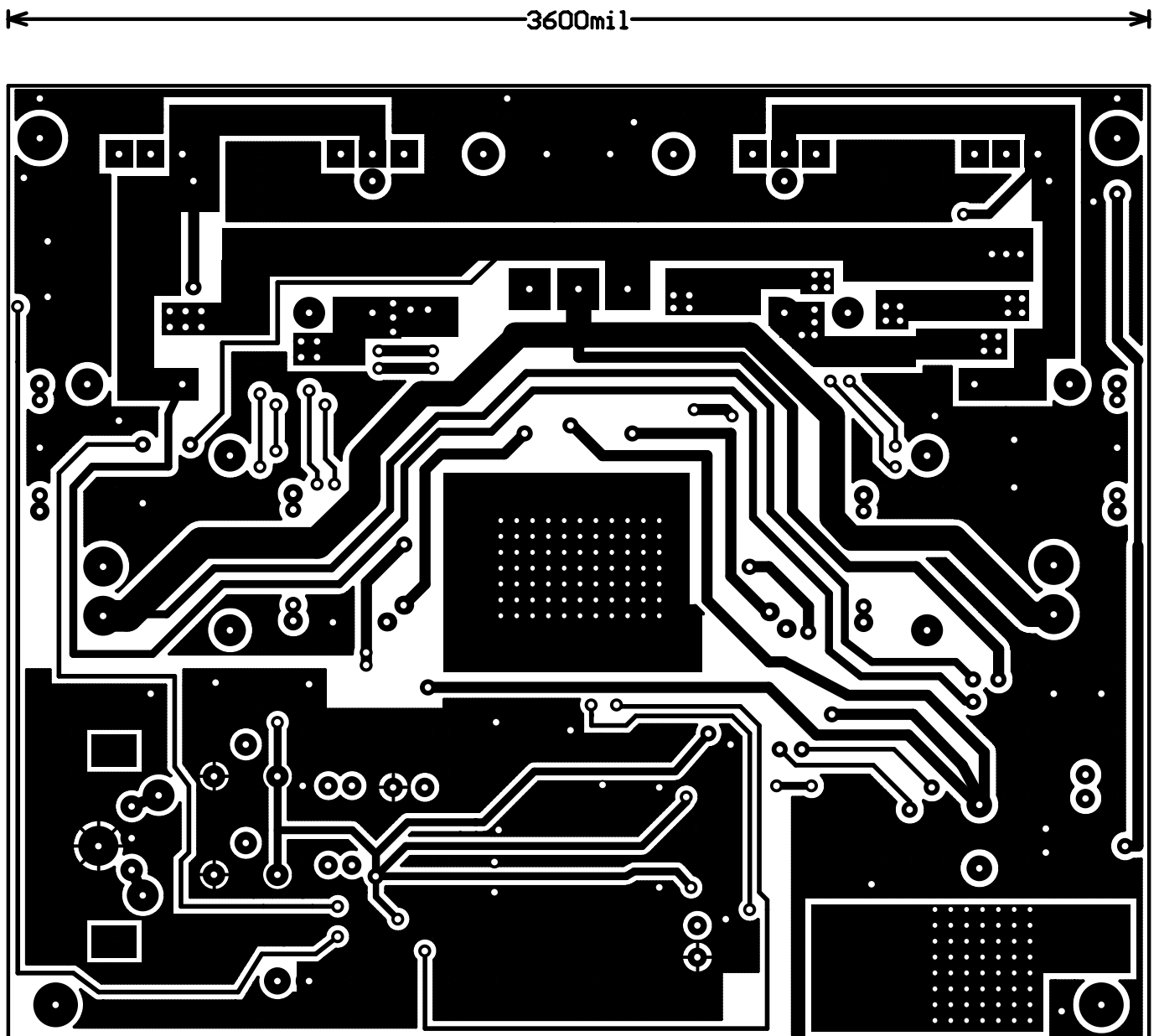
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Used	Part Type	Designator	Footprint	Part Field 1	Part Field 2	Part Field 3
1	0 OHM	R10	0805	*	*	*
4	0.01OHM/1W	R115 R116 R215 R216	2512	VISHAY	WSL2512R0100FTA	MSR 71-WSL2512-0.01
4	0.15uF/100V	C108 C109 C208 C209	C0U22PL10	PANASONIC	ECQ-V1154JM	DK P4727-ND
10	0.1uF	C1 C102 C11 C111 C2 C202 C211 C3 C4 C5	0805	20% TOL.	*	*
2	0.1uF/100V/X7R	C8 C9	1210	KEMET	C1210C104K1RACTU	DK 399-1268-1-ND
2	0.1uF/250V	C105 C205	2420	PANASONIC	ECW-U2104KC9	PCF1271CT-ND
4	1.07K, 1%	R107 R110 R207 R210	0805	*	*	*
1	1.21M, 1%	R5	0805	*	*	*
1	10 OHM, 5%	R8	0805	*	*	*
1	100uF/25V	C10	C10UEL05	PANASONIC	ECA-1EHG101	DK P5540-ND
1	100uH/0.5A	L2	IND1UH	TOKO	187LY-101J	DK TK4300-ND
4	15.0K, 1%	R106 R109 R206 R209	0805	*	*	*
4	15.4OHM/0.5W	R113 R114 R213 R214	2010	PANASONIC	ERJ-12SF15R4U	DK P15.4ACCT-ND
1	150pF	C107	0805	NPO 5%	*	*
2	18uH	L100 L200	T80	AMIDON INDUCTIVE	AW-940-06-46T-20-V	T94-2 CORE 46TURNS / 20AWG WIRE
6	1K, 1%	R105 R108 R205 R208 R3 R9	0805	*	*	*
2	1M, 5%	R102 R202	0805	*	*	*
2	2.2uF	C100 C200	C10UEL05	PANASONIC	ECA-1HHG2R2	DK P5564-ND
2	20K, 1%	R101 R201	0805	*	*	*
2	20OHM/2W	R117 R217	PWR2W	PANASONIC	ERG-2SJ200	DK P20W-2BK-ND
2	220pF	C103 C203	0805	NPO 5%	*	*
2	220uF/63V	C6 C7	C100UEL06	PANASONIC	EEU-FC1J221	DK P10346-ND
2	240 OHM, 5%	R112 R212	0805	*	*	*
2	27.4K, 1%	R111 R211	0805	*	*	*
1	270pF	C207	0805	NPO 5%	*	*
1	2K, 5%	R2	0805	*	*	*
2	30.1K, 1%	R100 R200	0805	*	*	*
2	33uF/160V	C113 C213	C100UEL06	PANASONIC	EEU-EB2C330	DK P5901-ND
1	402K, 1%	R4	0805	*	*	*
2	442K, 1%	R6 R7	0805	*	*	*
2	47uF/25V	C104 C204	C10UEL05	PANASONIC	ECA-1EHG470	DK P5539-ND
2	50K POT	R104 R204	POTSTURN	BOURNS	3306P-1-103	DK 3306P-103-ND
1	8.25K, 1%	R1	0805	*	*	*
4	AL02 SPACER	SPCR100 SPCR101 SPCR200 SPCR201	TO220SPACER	AAVID THERMALLOY	4170	*
2	CON2	J101 J201	PWR2	WALDOM	26-60-4020	DK WM4620-ND
1	CON2LPWR	J1	CON2B	WALDOM	22-23-2021	DK WM4200-ND
2	CON3	J3 J6	0805JMPR	0 OHM 0805	*	*
1	DUALRCA	J2	DUALRCAVERT	CUI INC.	RCJ-2223	DK CP-1435-ND
1	FBEAD	L1	2010	*	*	*
4	FDP2572	M100 M101 M200 M201	TO220	FAIRCHILD SEMI	FDP2572	*
1	HDR2	J4	GJMPR001	*	*	*
1	IRF9520NS	Q2	D2PAK2	INTERNATIONAL RECT.	IRF9520NS	DK IRF9520NS-ND
1	LED	D1	LED1	RED LED	*	*
11	MURS120T3	D102 D103 D104 D105 D106 D2 D202 D203 D204 D205 D206	SMB	ON SEMICONDUCTOR	MURS120T3	NWK 08F2006
1	PWRCON3	J5	CON3	WALDOM	26-60-4030	DK WM4621-ND
1	TC2001	U1	SOP28	TRIPATH TECHNOLOGY	*	*
1	TP2150	U2	LQFP64	TRIPATH TECHNOLOGY	*	*
2	WIRE JMPR	JMPR100 JMPR200	JMPR100	14 AWG WIRE		



FABRICATION NOTES

THIS IS A DOUBLE SIDED BOARD

MATERIAL: FR-4 OR EQUIVALENT

0.062 +/- 0.007 THICKNESS

2 OZ COPPER, ALL LAYERS

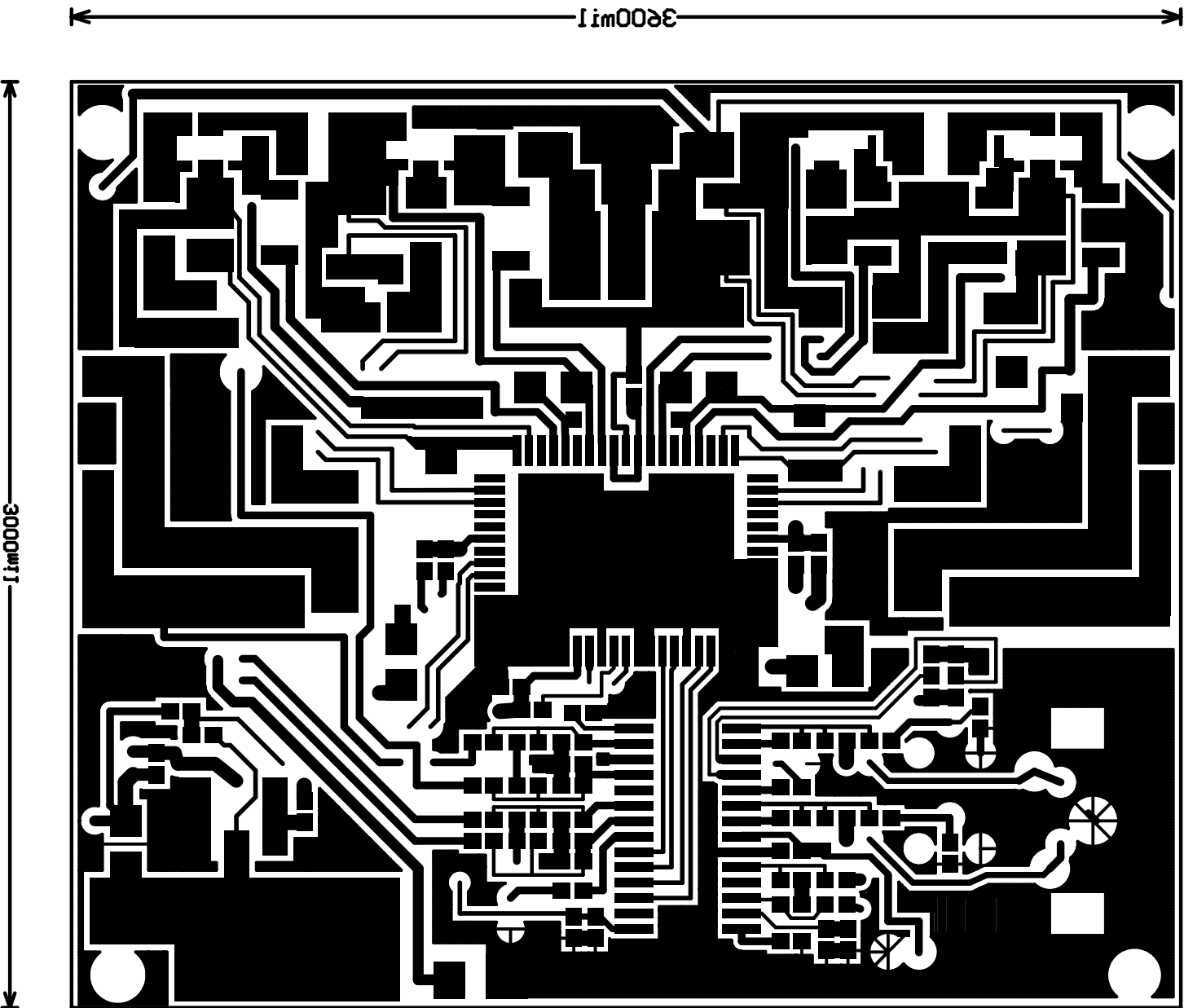
SOLDERMASK OVER BARE COPPER, USE GREEN

SILKSCREEN TO BE WHITE

TOP SIDE SILKSCREEN MUST COVER TOP SOLDERMASK
THUS, THE COPPER ON VIAS AND PADS SHOULD NOT APPEAR
IF THERE IS SILKSCREEN AT SAME POSITION

NOTE: THERE ARE TWO SLOTS ON THIS BOARD
110mil x 70mil

SLOTS SHOULD BE PLATED THRU
FABRICATE PER IPC STANDARDS
Board size is 3.00 x3.60



FABRICATION NOTES
 THIS IS A DOUBLE SIDED BOARD
 MATERIAL: FR-4 OR EQUIVALENT
 0.082 + - 0.003 THICKNESS
 2 OZ COPPER, ALL LAYERS
 SOLDERMASK OVER BARE COPPER, USE GREEN
 SILKSCREEN TO BE WHITE
 TOP SIDE SILKSCREEN MUST COVER TOP SOLDERMASK
 THUS, THE COPPER ON VIAS AND PADS SHOULD NOT APPEAR
 IF THERE IS SILKSCREEN AT SAME POSITION
 NOTE: THERE ARE TWO SLOTS ON THIS BOARD
 110mm x 70mm

SLOTS SHOULD BE PLATED THRU
 FABRICATE PER IPC STANDARDS
 Board size is 3.00 x 3.00

