TAS5066-5121K6EVM Application Report

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The TAS5066-5121K6EVM PurePath Digital™ customer evaluation module demonstrates two integrated circuits TAS5066 and TAS5121DKD from Texas Instruments (TI).

The TAS5066 is a high-performance 24-bit six-channel digital pulse width modulator (PWM) based Equibit™ technology. The TAS5066 has a wide variety of serial input (I²S) options including right justified, left justified and DSP data formats. It accepts I²S data with sample rates up to 192kHz.

TAS5121DKD is a compact, high-power, digital amplifier power stage designed to drive a 4-Ohm loudspeaker up to 100 W. It contains integrated gate-drivers, four matched and electrically isolated enhancement-mode N-channel power DMOS transistors, and protection / fault-reporting circuitry.

The TAS5066-5121K6EVM, together with a TI input board, is a complete digital audio amplifier system that includes digital input (S/PDIF), analog inputs, interface to PC, digital volume control, and failure protection. The system was design for home theater applications such as DVD minicomponent systems, home theater in a box (HTIB), DVD receivers, A/V receivers, or plasma display panels (PDP).

This document covers:

- EVM Specifications
- Audio performance and power efficiency graphs:
  - THD+N versus Power
  - THD+N versus Frequency
  - FFT Spectra with dithered -60dB Fs tone
  - Idle Channel Noise FFT Spectra
  - Channel Separation
  - Gain-Frequency Response
- Design documentation of the EVM:
  - Schematics
  - Parts list
  - PCB specification & layout
  - Mechanical design

For EVM setup and use, please see “TAS5066-5121K6EVM User’s Guide”.

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1 TAS5066-5121K6EVM Specification

Table 1. General Test Conditions

General Test Conditions		Notes
Output Stage Power Supply (PVDD):	30.5 V	Laboratory Power Supply (EA-PS 7065-10A).
System Power Supply:	15 V	
Load Impedance:	4 ohm	
Sampling Frequency	48 kHz	
PWM Processor	TAS5066	
Output stage	TAS5121DKD	

Table 2. Electrical Data

Electrical Data		Notes/Conditions
Output Power 4 ohm:	75 W/Channel	<0.2% THD+N, 1 kHz.
Output Power 4 ohm, 10% THD:	100 W/Channel	10% THD+N, 1 kHz.
Output Power 6 ohm:	55 W/Channel	<0.09% THD+N, 1 kHz.
Output Power 8 ohm:	44 W/Channel	<0.09% THD+N, 1 kHz.
Maximum Output Power pr Channel	75 W/Channel	2 x 75W for 5 min, 1 kHz, preheated 1 hour at 6x25W.
Output Stage Efficiency:	88 %	P_{OUT} = 2 x 85W, 1 kHz.
Total Board Idle Power Consumption:	7 W	
Rated Load Impedance:	4-8 Ohm	
Damping factor	16	1kHz, relative to 8 ohm load.
Maximum Peak Current:	> 10 A	1kHz burst, 1 ohm.
System Power Supply Current	200 mA	Including TI Input board.

Table 3. Audio Performance

Audio Performance		Notes/Conditions
THD+N, 1 watt:	<0.05 %	1 kHz.
THD+N, 10 watt:	<0.19 %	1 kHz.
THD+N, 75 watt:	<0.2 %	1 kHz.
Dynamic Range:	>97 dB	Ref: rated power, A-weighted, AES17 filter.
Noise Voltage	<250 μV_{RMS}	A-weighted, AES17 filter.
Channel separation:	63 dB	1 kHz, P_{OUT} = 75W.
Amplitude Response 20–20kHz	+0.6dB / –0.1dB	4 ohm / 75 Watts unclipped.

Table 4. Thermal Specification

Thermal specification		Notes/Conditions
Idle mode, all channels switching	45 °C	1 kHz.
6 x 1/3 Output Power	58 °C	1 kHz, 1 hour.
2 x 75W (4 ohm)	65 °C	1 kHz, 5 min.

Note: Amplifier mounted with a prototype heat sink, free air.

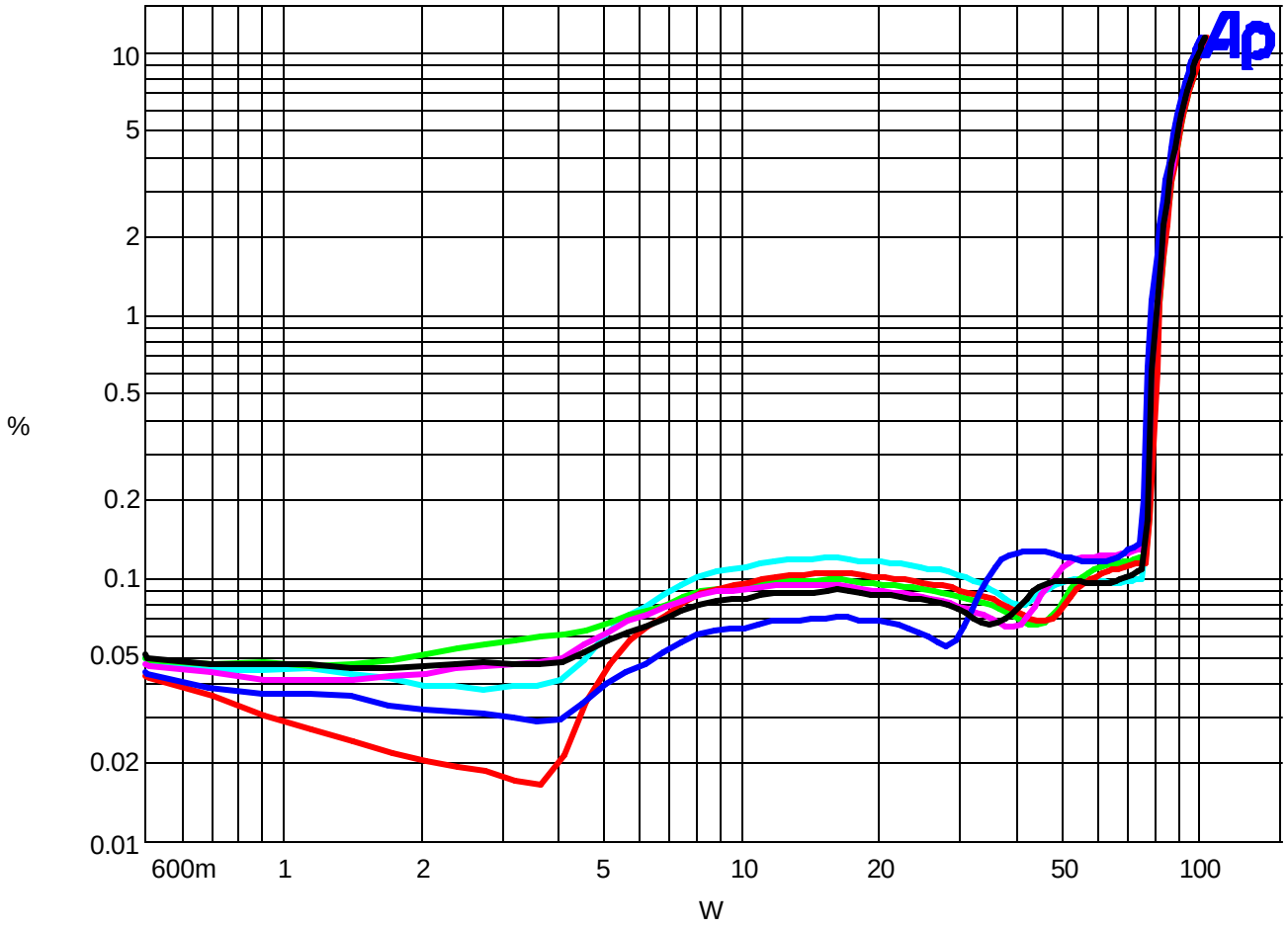
Table 5. Physical Specification

Physical Specifications		Notes/Conditions
PCB Dimensions:	134 x 147 mm	Length x Width.
Heat sink:	125 x 32 x 35 mm	Length x Width x Height.
Total weight:	425 g	Components + PCB + Mechanics.

Note: All electrical and audio specifications are typical values and measured at $T_{AMBIENT}$ = 25°C.

1.1 THD+N versus Power

Channel 1 - 6

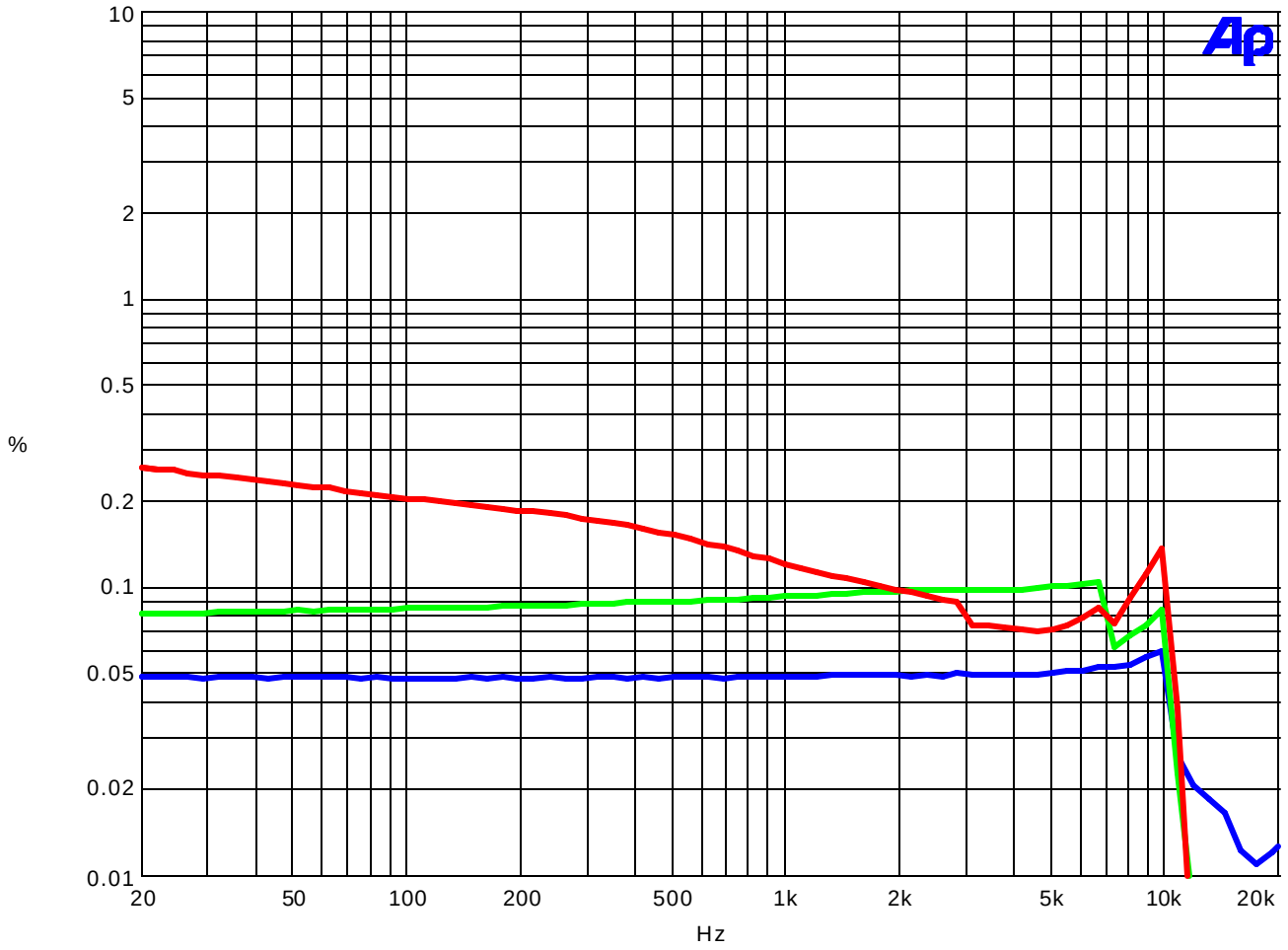


Comments:	Power supply: 30.5 V	Load: 4 ohm	Filter: AES17
	Input signal: 1 kHz	+ 2.5 dB gain in TAS5066	Sample frequency: 48 kHz

Figure 1. THD+N versus Power

1.2 THD+N versus Frequency

Channel 1



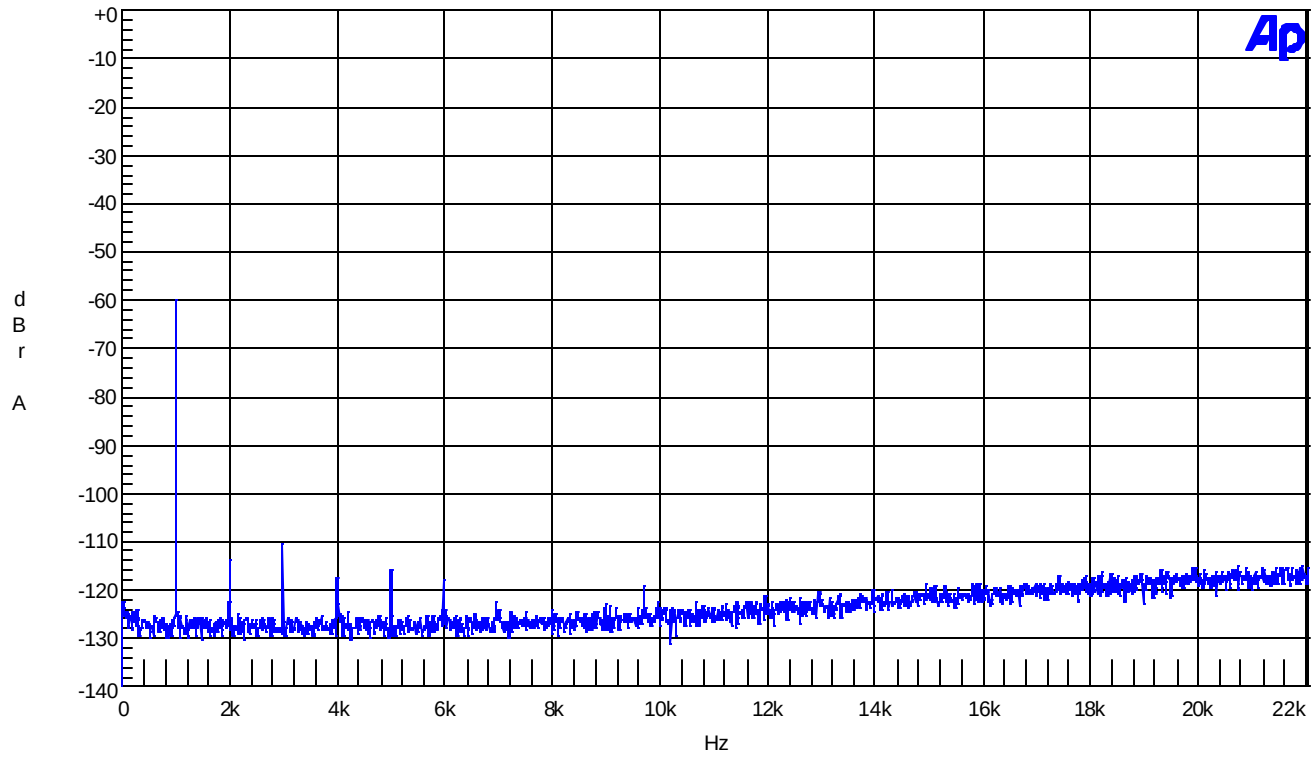
Comments:	Blue: 1 watt	Green: 10 watts	Red: 75 watts	Sample frequency: 48 kHz
	Power supply: 30.5V DC	Load: 4 ohm	Filter: AES17	

Note: THD+N at high frequencies depend on the output-filter coil material.

Figure 2. THD+N versus Frequency

1.3 FFT with -60dB Input Signal

Channel 1

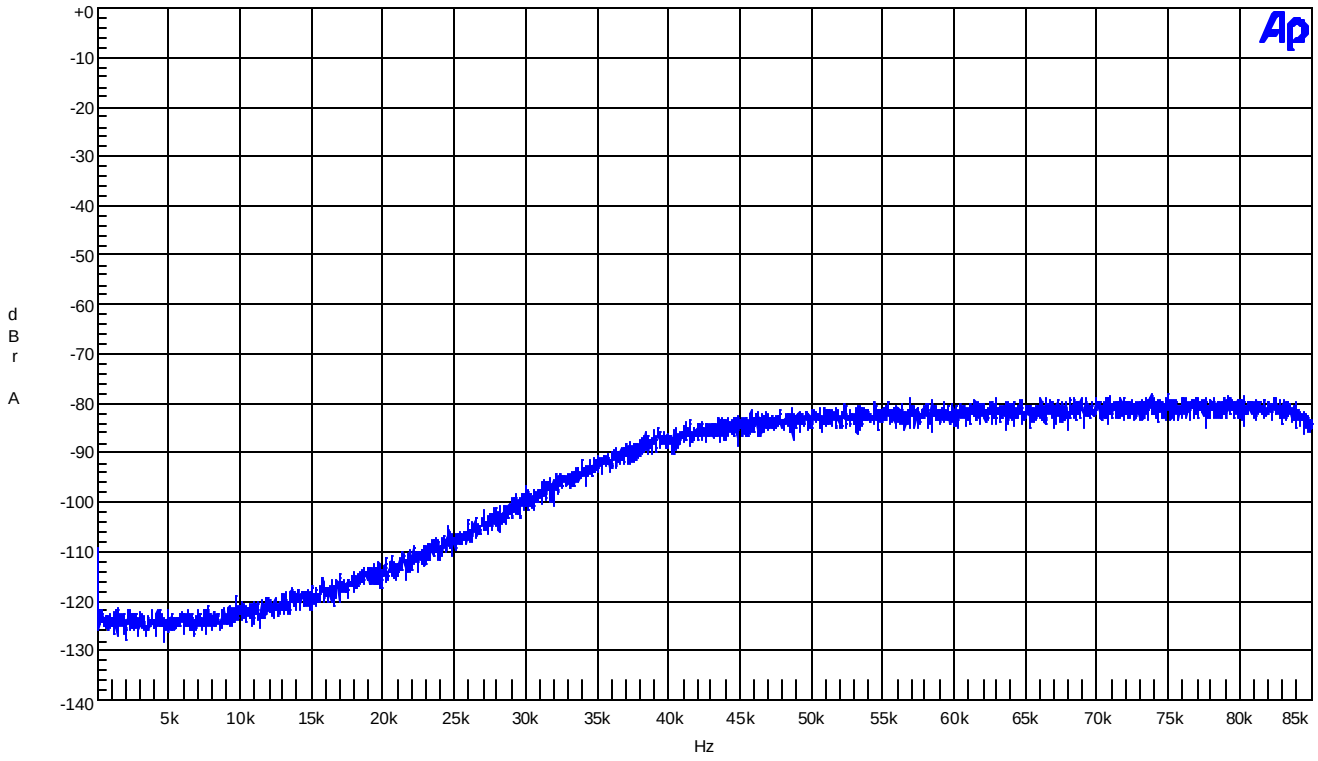


Comments:	Power supply: 30.5V DC	Load: 4 ohm	Filter: AES17	
	Input signal: 1 kHz	Sample frequency: 48 kHz	FFT size: 16k	Reference: 17.8 volt = full scale

Figure 3. FFT with -60dB Input Signal

1.4 Noise-Floor

Channel 1

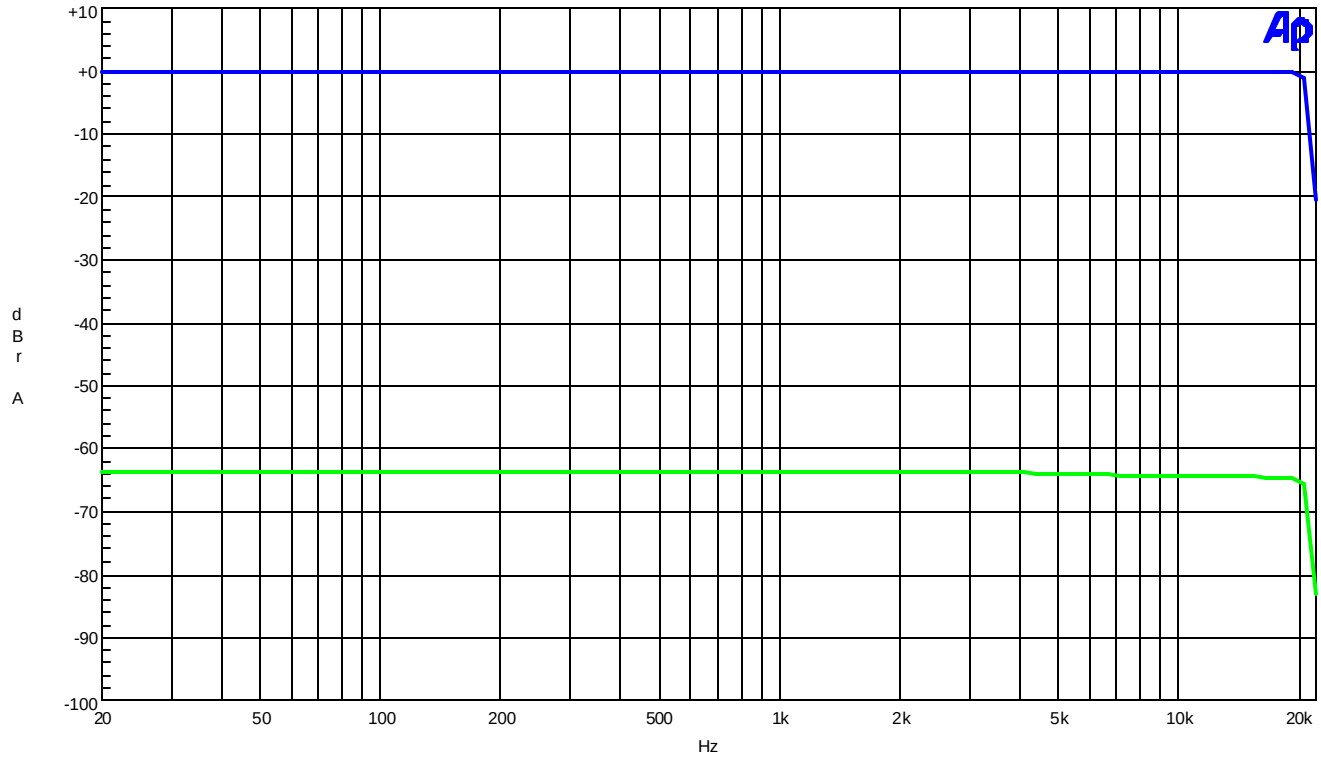


Comments:	Power supply: 30.5 V DC Input signal: 0 Fs	Load: 4 ohm Sample frequency: 48 kHz	FFT size: 16k	Reference: 17.8 volt = full scale

Figure 4. Noise-Floor

1.5 Channel Separation versus Frequency

Channel 1 – 2

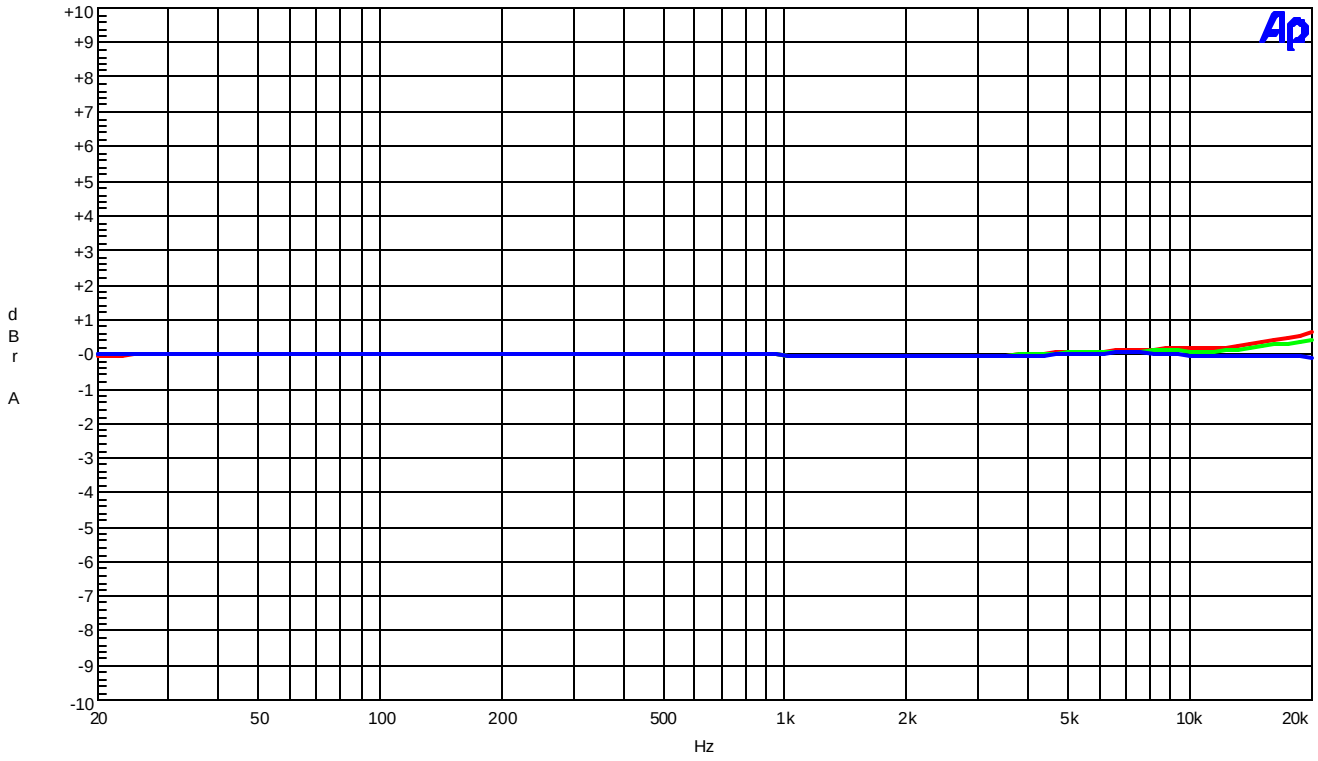


Comments:	**Blue: Channel 1**	**Green: Channel 2**		
	Input channel 1: 1 Fs	Load: 4 ohm	Sample frequency: 48 kHz	Reference: 17.8 volts = full scale
	Input channel 2: 0 Fs	Filter: AES17	Power supply: 30.5 V DC	

Figure 5. Channel Separation versus Frequency

1.6 Frequency Response

Channel 1

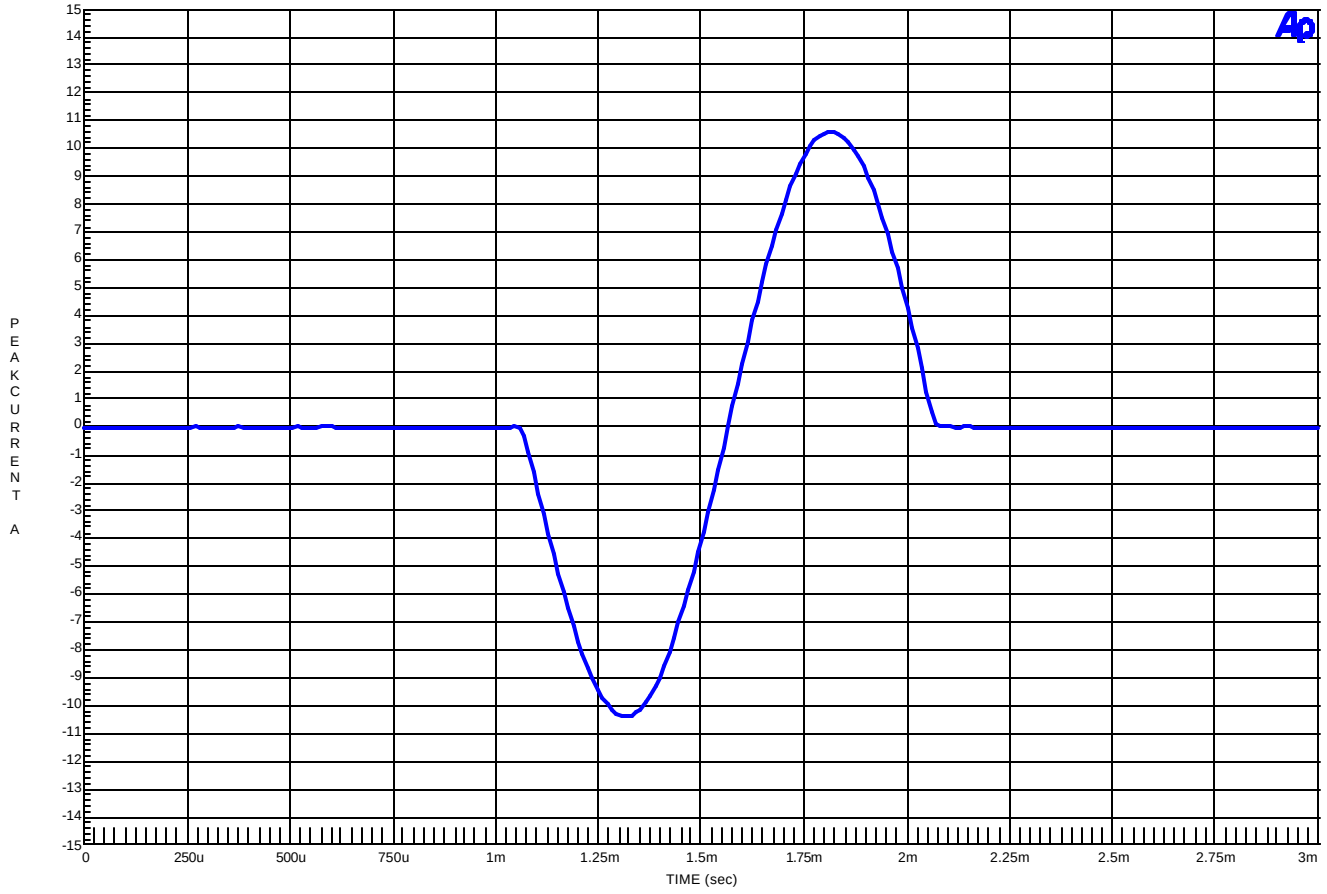


Comments:	Blue: 4 ohms load	Green: 6 ohms load	Red: 8 ohms load	Power supply: 30.5 V DC
	Input signal: 1 kHz	Sample frequency: 48 kHz		

Figure 6. Frequency Response

1.7 Peak Current

Channel 1

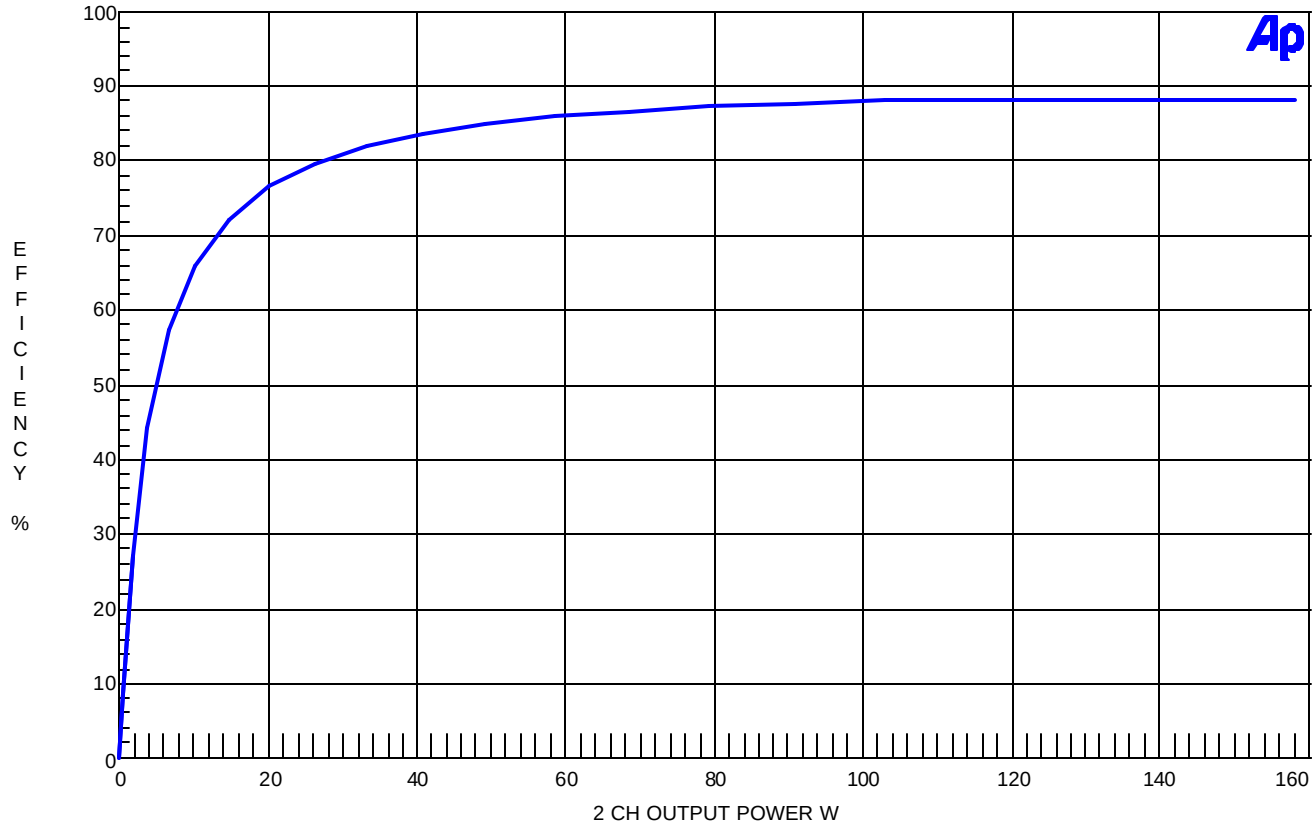


Comments:	**Blue: 1 ohm load**		
	Input signal: 1 kHz	Sample frequency: 48 kHz	Power supply: 30.5 V DC

Figure 7. Peak Current with a 1-Ohm Load

1.8 Output Stage Efficiency

Amplifier Efficiency versus Total Delivered Power



Comments:	Input signal: 1 kHz	Sample frequency: 48 kHz	Load: 4 ohm	Power supply: 30.5 volt

Figure 8. Output Stage Efficiency

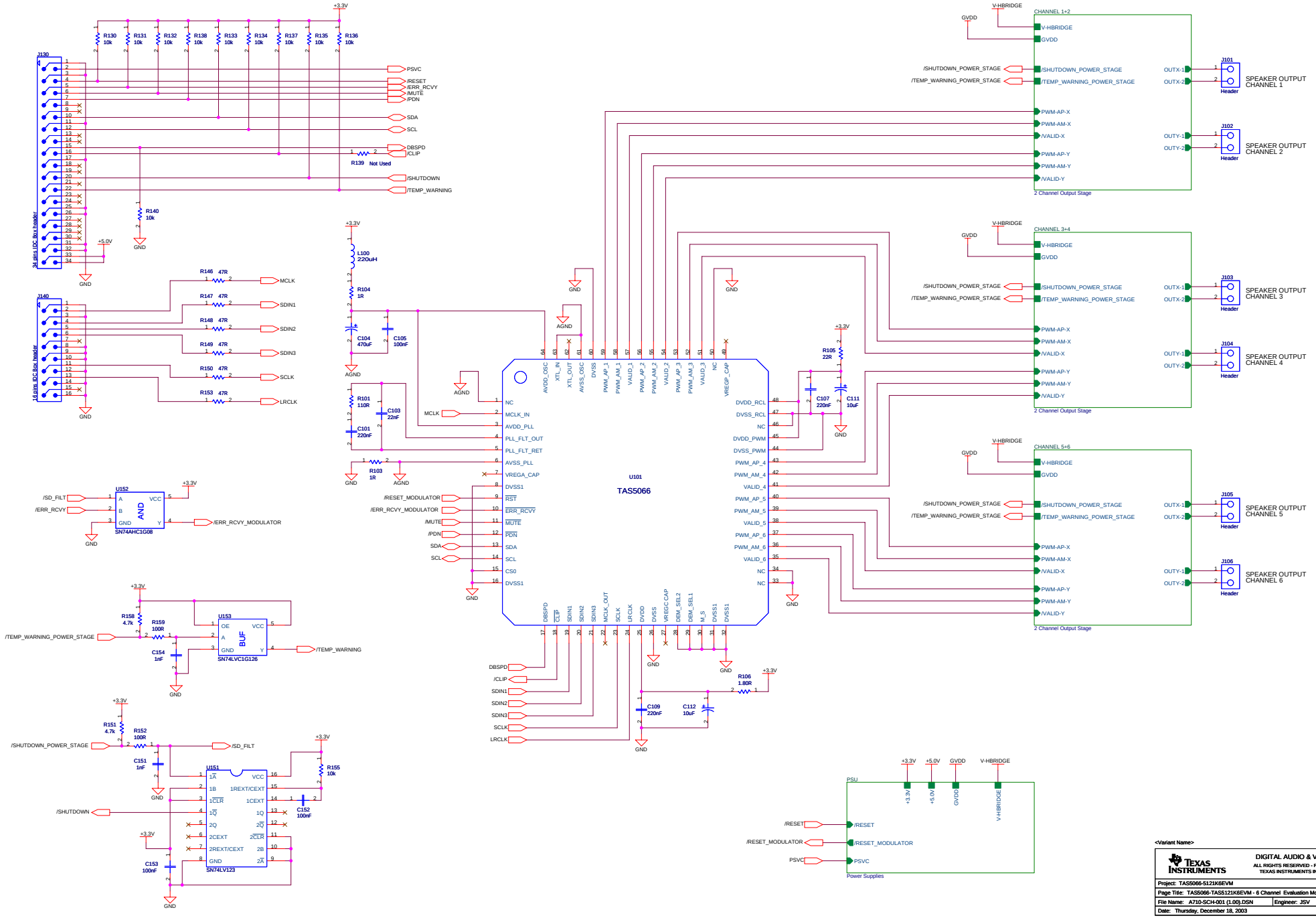
2 References

1. *System Design Considerations for True Digital Audio Power Amplifiers* (SLAA117)
2. *Digital Audio Measurements* (SLAA114)

Appendix A. Design documents

TAS5066-5121K6EVM Schematic	Version 1.00	6 pages
TAS5066-5121K6EVM Partslist	Version 1.00	3 pages
TAS5066-5121K6EVM PCB specification	Version 2.00	1 page
TAS5066-5121K6EVM PCB layers	Version 2.00	4 pages
TAS5066-5121K6EVM Mechanical design	Version 1.00	3 pages

TAS5066-5121K6EVM



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TEXAS INSTRUMENTS

DIGITAL AUDIO & VIDEO DIVISION

Project: TAS5066-5121K6EVM	Rev: 1.00
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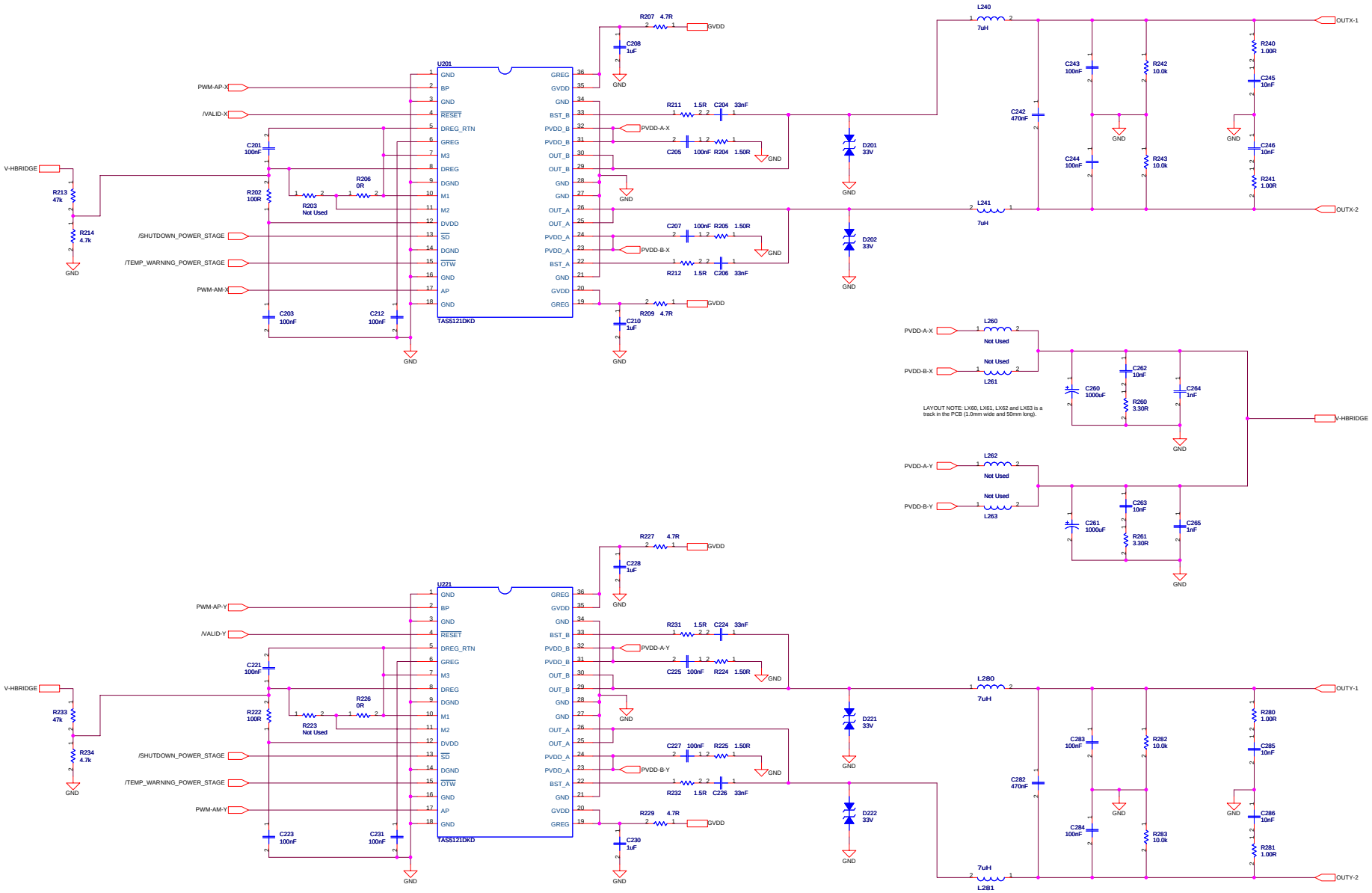
File Name: A710-SCH-001 (1.00).DSN	Engineer: JSV
Date: Thursday, December 18, 2003	Page: 1 of 8

2 CHANNEL OUTPUT STAGE DESIGN



Patents pending in circuitry design and layout (WO99/59241 & WO99/59242).

This circuitry may only be used together with the integrated circuit TAS5121DKD from Texas Instruments Incorporated.

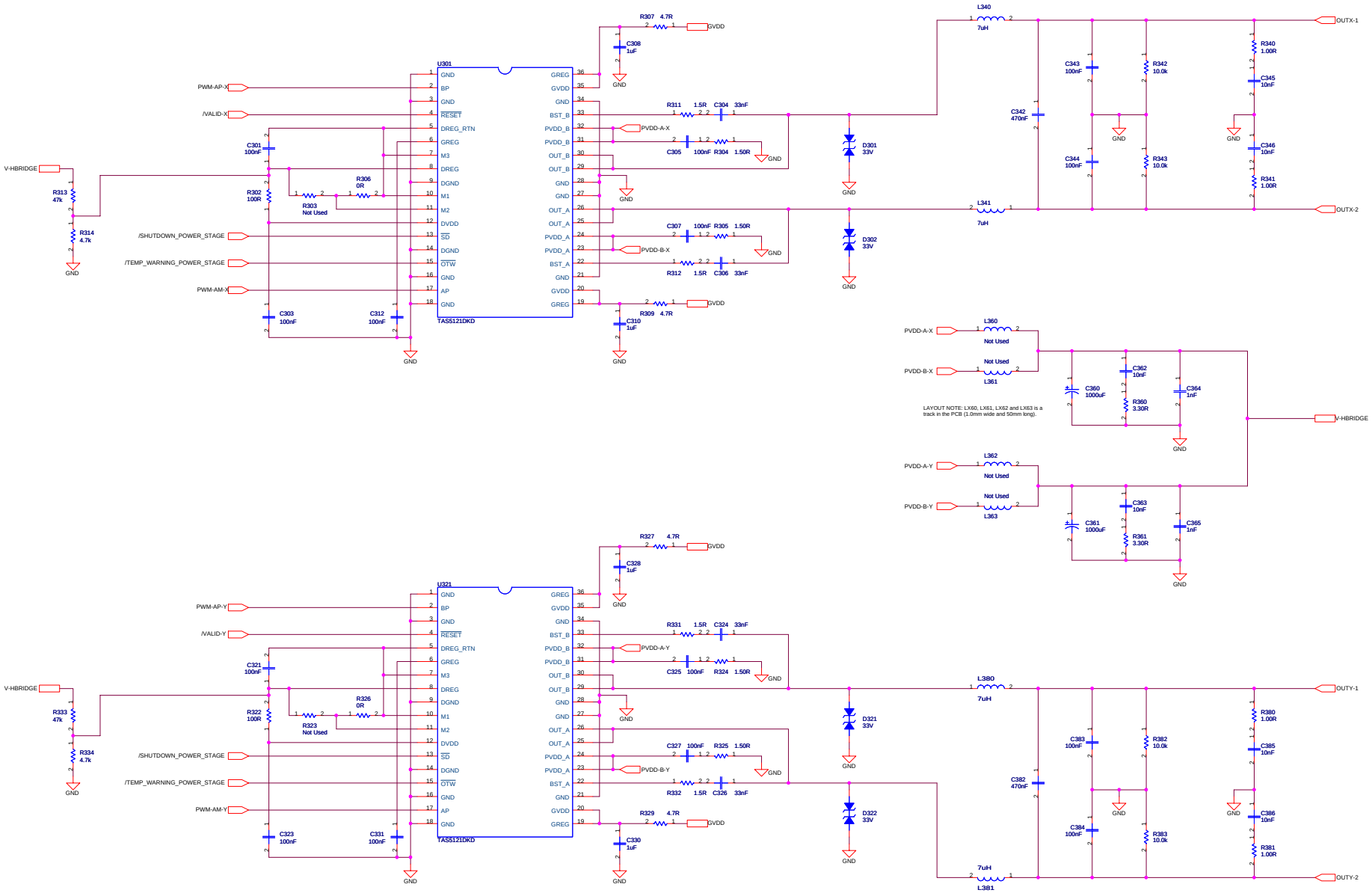
<Variant Name>

TEXAS INSTRUMENTS

DIGITAL AUDIO & VIDEO DIVISION

Project: TAS5066-5121K6EVM	Rev: 1.00
Page Title: Channel 1+2	Size: A2
File Name: A710-SCH-001 (1.00).DSN	Engineer: JSV
Date: Monday, December 01, 2003	Page: 2 of 6

2 CHANNEL OUTPUT STAGE DESIGN



Patents pending in circuitry design and layout (WO99/59241 & WO99/59242).

This circuitry may only be used together with the integrated circuit TAS5121DKD from Texas Instruments Incorporated.

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File Name: A710-SCH-001 (1.00).DSN	Engineer: JSV
Date: Monday, December 01, 2003	Page: 3 of 6

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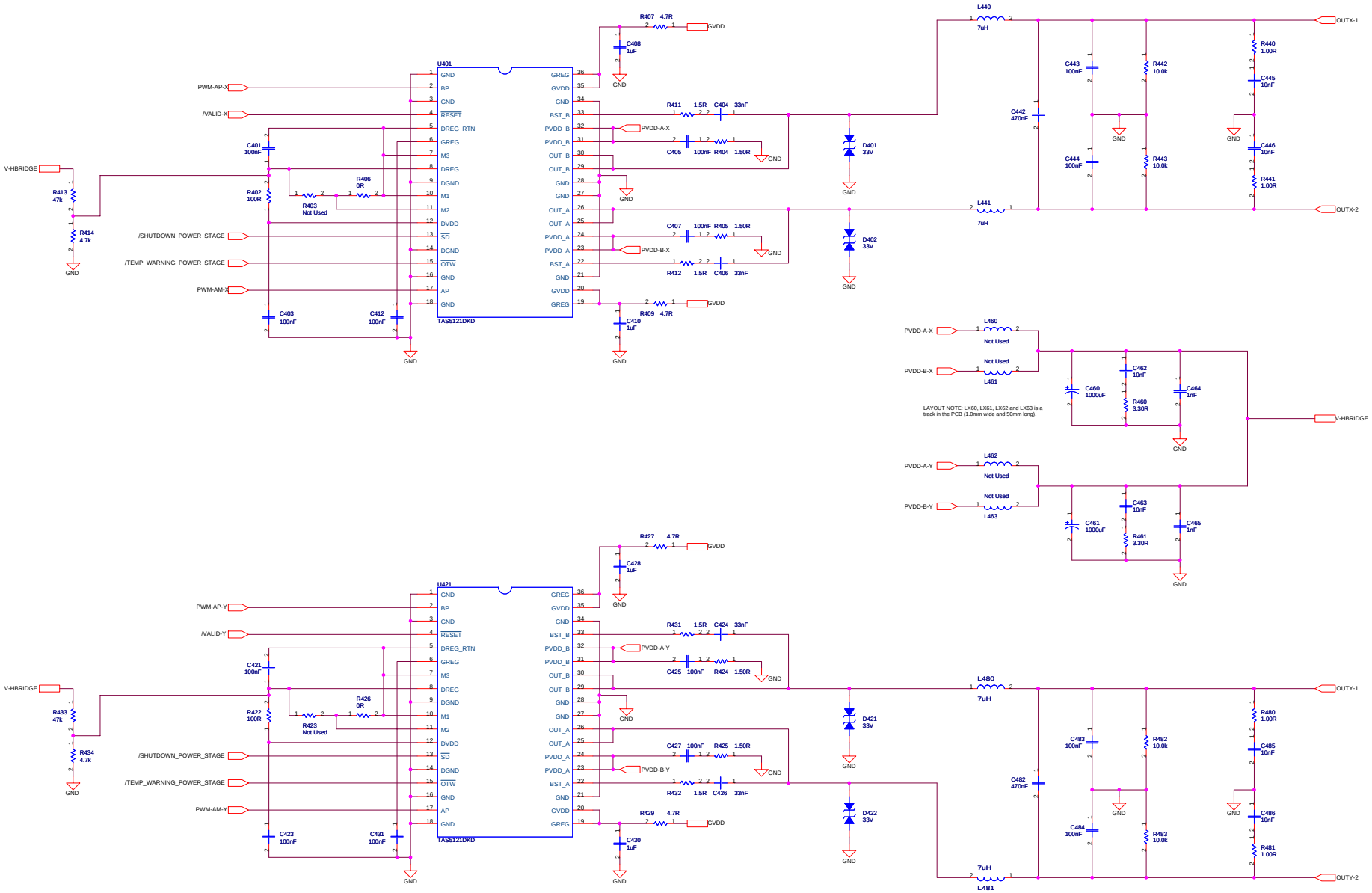

Patents pending in circuitry design and layout (WO99/59241 & WO99/59242).

This circuitry may only be used together with the integrated circuit TAS5121DKD from Texas Instruments Incorporated.

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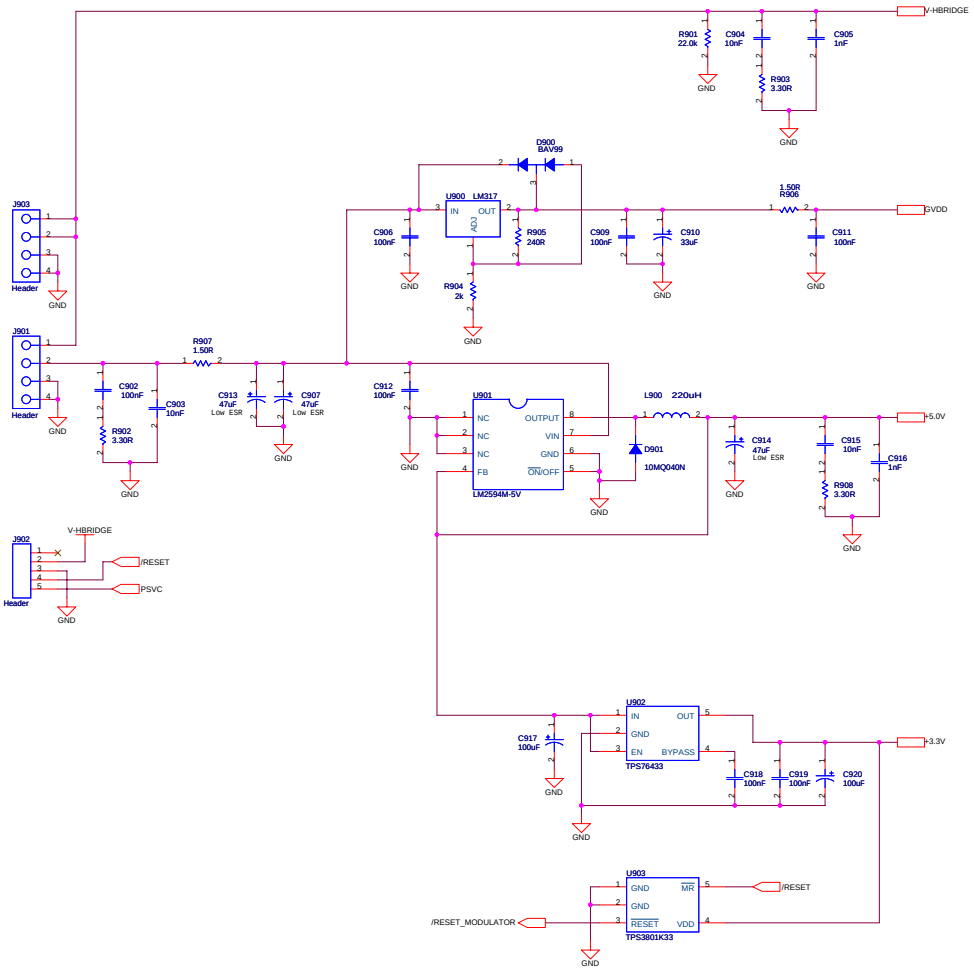
Date: Monday, December 01, 2003	Page: 4 of 6



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TEXAS INSTRUMENTS

DIGITAL AUDIO & VIDEO DIVISION

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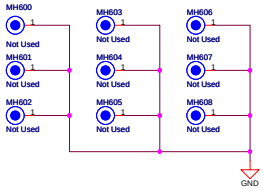
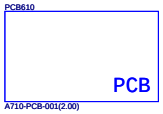
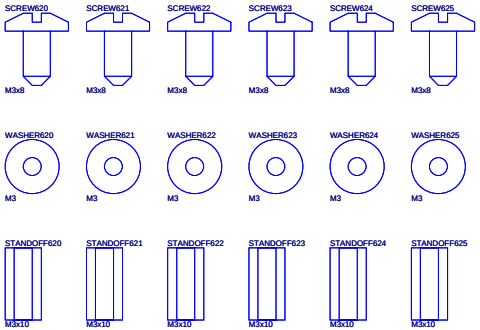
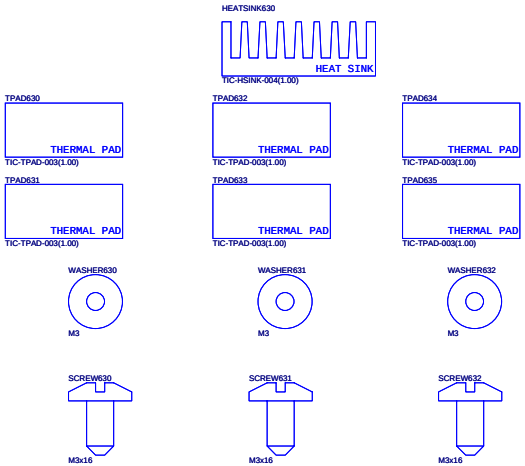
Date: Thursday, December 18, 2003	Page: 5 of 6

MECHANICS









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TEXAS INSTRUMENTS

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Page Title: MECHANICS	Size: A2
File Name: A710-SCH-001 (1.00).DSN	Engineer: JSV
Date: Thursday, December 18, 2003	Page: 6 of 6

TAS5066-5121K6EVM Parts List (1.00).xls

Qty	Part Reference	Description	Manufacture	First Mfr P/N
12	R242 R342 R442 R243 R343 R443 R282 R382 R482 R283 R383 R483	10.0k/250mW 1% 1206 Metal Film Resistor	BC Components	DCA 1206 1% 10k0
12	R240 R340 R440 R241 R341 R441 R280 R380 R480 R281 R381 R481	1.00R/125mW 1% 0805 Metal Film Resistor	BC Components	DCU 0805 1% 1R00
1	R901	22.0k/125mW 1% 0805 Metal Film Resistor	BC Components	DCU 0805 1% 22k0
9	R902 R903 R908 R260 R360 R460 R261 R361 R461	3.30R/125mW 1% 0805 Metal Film Resistor	BC Components	DCU 0805 1% 3R30
6	R206 R306 R406 R226 R326 R426	0R 0603 Metal Film Resistor	BC Components	DCT 0603 JUMPER
6	R202 R302 R402 R222 R322 R422	100R/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 100R
2	R152 R159	100R/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 100R
11	R130 R131 R132 R133 R134 R135 R136 R137 R138 R140 R155	10k/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 10k0
2	R103 R104	1R/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 1R00
1	R101	110R/100mW 1% 0603 Metal Film Resistor	BC Components	DCT 0603 1% 110R
12	R211 R311 R411 R212 R312 R412 R231 R331 R431 R232 R332 R432	1.5R/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 1R50
1	R106	1.80R/100mW 1% 0603 Metal Film Resistor	BC Components	DCT 0603 1% 1R80
1	R904	2k/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 2k00
1	R105	22R/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 22R
1	R905	240R/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 240R
8	R214 R314 R414 R234 R334 R434 R151 R158	4.7k/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 4k70
6	R213 R313 R413 R233 R333 R433	47k/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 47k0
12	R207 R307 R407 R209 R309 R409 R227 R327 R427 R229 R329 R429	4.7R/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 4R70
6	R146 R147 R148 R149 R150 R153	47R/100mW 5% 0603 Metal Film Resistor	BC Components	DCT 0603 5% 47R0
12	R204 R304 R404 R205 R305 R405 R224 R324 R424 R225 R325 R425	1.50R/250mW 5% RC3715 Mini-Melf Resistor	BC Components	MMA0204-50 5% BL 1R50
2	R906 R907	1.50R/250mW 5% RC3715 Mini-Melf Resistor	BC Components	MMA0204-50 5% BL 1R50
21	C903 C904 C915 C245 C345 C445 C246 C346 C446 C262 C362 C462 C263 C363 C463 C285 C385 C485 C286 C386 C486	Ceramic 10nF/100V 20% X7R 0805 Capacitor	BC Components	0805B103M101NT
25	C902 C205 C305 C405 C207 C307 C407 C225 C325 C425 C227 C327 C427 C243 C343 C443 C244 C344 C444 C283 C383 C483 C284 C384 C484	Ceramic 100nF/50V 20% X7R 0805 Capacitor	BC Components	0805B104M500NT
12	C208 C308 C408 C210 C310 C410 C228 C328 C428 C230 C330 C430	Ceramic 1uF/16V 20% X7R 0805 Capacitor	BC Components	0805B105M160NT
3	C101 C107 C109	Ceramic 220nF/16V 20% X7R 0805 Capacitor	BC Components	0805B224M160NT

12	C204 C304 C404 C206 C306 C406 C224 C324 C424 C226 C326 C426	Ceramic 33nF/100V 20% X7R 1206 Capacitor	BC Components	1206B333M101NT
8	C905 C916 C264 C364 C464 C265 C365 C465	Ceramic 1nF/50V 2% NP0 0805 Capacitor	BC Components	0805N102G500NT
2	C111 C112	Electrolytic 10uF/16V 20% Aluminium 4x5mm SMD Capacitor	Panasonic	ECEV1CA100SR
2	C917 C920	Electrolytic 100uF/6.3V 20% Aluminium 6x7mm SMD Ultra Low ESR Capacitor	Panasonic	EEVFK0J101P
1	C910	Electrolytic 33uF/25V 20% Aluminium 6x7mm SMD Capacitor	Panasonic	ECEV1EA330SP
1	C104	Electrolytic 470uF/16V 20% Aluminium 8x10mm SMD Low ESR Capacitor	Panasonic	EEVFK1C471P
18	C201 C301 C401 C203 C303 C403 C212 C312 C412 C221 C321 C421 C223 C323 C423 C231 C331 C431	Ceramic 100nF/16V 20% X7R 0603 Capacitor	BC Components	0603B104M160NT
9	C105 C906 C909 C911 C912 C918 C919 C152 C153	Ceramic 100nF/16V 20% X7R 0603 Capacitor	BC Components	0603B104M160NT
1	C103	Ceramic 22nF/50V 20% X7R 0603 Capacitor	BC Components	0603B223M500NT
2	C151 C154	Ceramic 1nF/50V 10% NP0 0603 Capacitor	BC Components	0603N102K500NT
6	C260 C360 C460 C261 C361 C461	Electrolytic 1000uF/35V 20% Aluminium 5mm ø12.5mm Low ESR Capacitor	Panasonic	EEUFC1V102
3	C907 C913 C914	Electrolytic 47uF/35V 20% Aluminium 2.5mm ø6.3mm Low ESR Capacitor	RUBYCON	35YXF47MY0611
6	C242 C342 C442 C282 C382 C482	Metal Film 470nF/100V 10% Polyester 7.5mm (W:5mm L:10.3mm) Capacitor	Wima	MKS 4 0.47uF/10%/100Vdc PCM7.5
1	L900	220uH/0.5A 20% (390mR) Magnetically shielded Ferrite Inductor	CoilCraft	DT3316P-224
1	L100	220uH/45mA 10% Ferrite Inductor (1210)	Panasonic	ELJFA221KJF
6	L240 L340 L440 L241 L341 L441	7uH/8A (30mR) Low THD+N Ferrite Inductor	Fe-Tronic	TIC-INDC-003 (1.00)
6	L280 L380 L480 L281 L381 L481	7uH/8A (30mR) Low THD+N Ferrite Inductor	Fe-Tronic	TIC-INDC-003 (1.00)
1	D900	250mA/70V 350mW Small Signal Dual (A-C-CA) Diode (SOT-23)	General Semi.	BAV99
1	D901	1A/40V Schottky Diode (SMA)	Int. Rectifier	10MQ040N
12	D201 D301 D401 D202 D302 D402 D221 D321 D421 D222 D322 D422	33V 400W (1ms) Zener Bidictional Transient Voltage Suppressor Diode (SMA)	ON/Motorola	1SMA33CAT3
1	U101	6 ch PWM processor (AD, VOL, 192kHz, High BW) (TQFP64)	Texas Instruments	TAS5066PFB
6	U201 U301 U401 U221 U321 U421	Mono Digital Audio PWM Power Output Stage (PSOP3-36)	Texas Instruments	TAS5121DKD
1	U152	Single AND gate, AHC (SOT23-5)	Texas Instruments	SN74AHC1G08DBVR
1	U151	Dual Retriggerable Monostable Multivibrators, LV (TSSOP16)	Texas Instruments	SN74LV123APWR
1	U153	Single Bus Buffer, LVC (SOT23-5)	Texas Instruments	SN74LVC1G126DBVR
1	U903	3.3V Supply Voltage Supervisor (SOT323-5)	Texas Instruments	TPS3801K33DCK
1	U900	0.5A Positive Adjustable Regulator (KTP)	Texas Instruments	LM317MKTP
1	U901	5V/0.5A Buck Converter (SO8)	National Semi.	LM2594M-5.0V
1	U902	3.3V/150mA Low Drop Linear Regulator (SOT23-5)	Texas Instruments	TPS76433DBVR
3	SCREW630 SCREW631 SCREW632	M3x16 Pozidriv Stainless Steel Screw	Bossard	BN 31108 M3x16

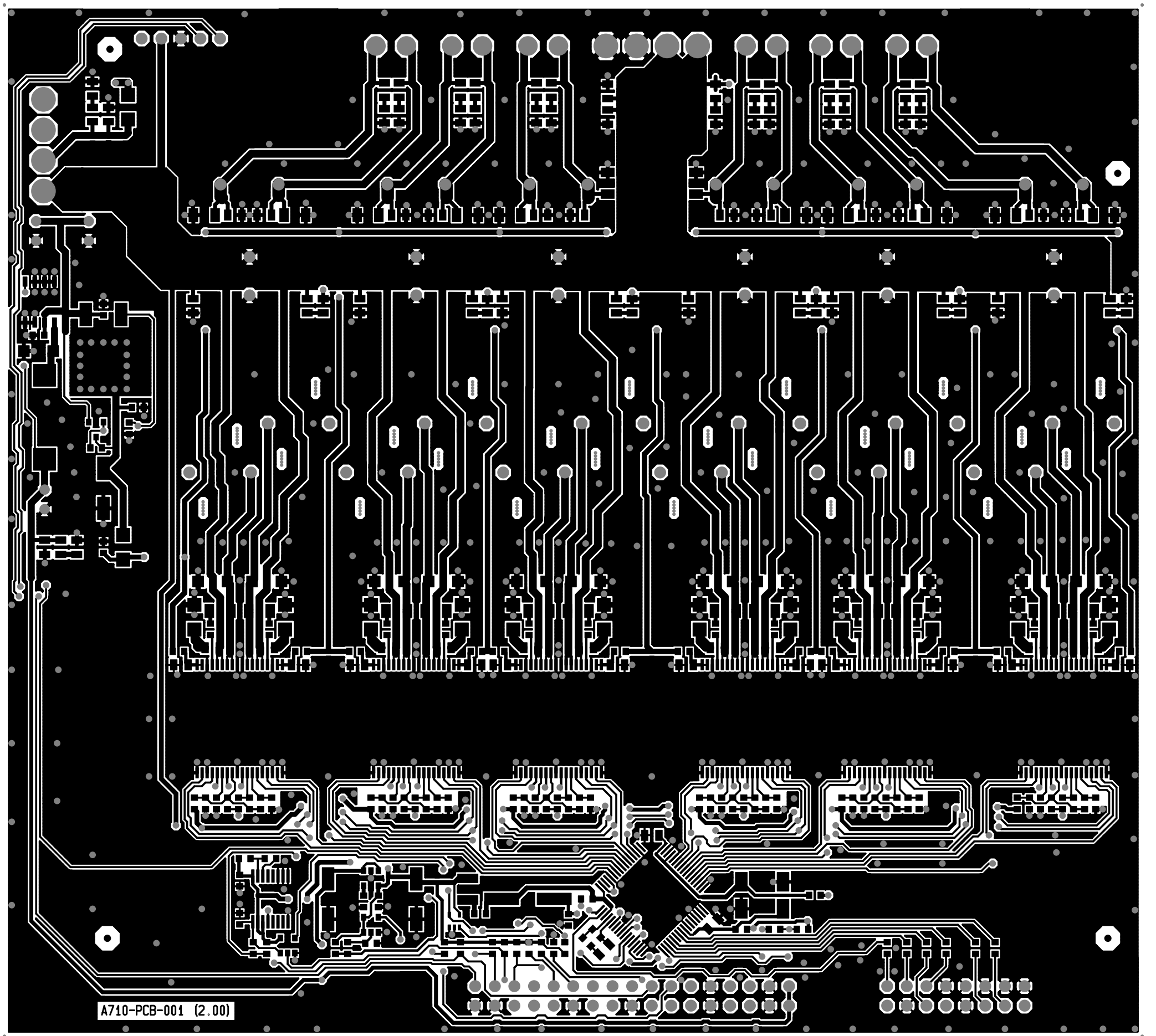
6	SCREW620 SCREW621 SCREW622 SCREW623 SCREW624 SCREW625	M3x8, Pan Head, Pozidriv, A2 Screw	Bossard	BN 31108 M3x8
6	WASHER620 WASHER621 WASHER622 WASHER623 WASHER624 WASHER625	M3 Stainless Steel Washer	Bossard	BN 670 M3
3	WASHER630 WASHER631 WASHER632	M3 White Nylon (o/d:9.0 i/d:3.2 t:0.8) Washer	Bossard	BN1075 M3
6	STANDOFF620 STANDOFF621 STANDOFF622 STANDOFF623 STANDOFF624 STANDOFF625	M3x10 Aluminum Stand-off	Ettinger	05.03.108
1	J902	5 pins/1 row/2.54mm Pitch Vertical Male Friction lock Pin header	Molex	22-27-2051
6	J101 J102 J103 J104 J105 J106	2 pins/1 row/3.96mm Pitch Vertical Male Pin header	JST	B2P-VH
1	J901 J903	4 pins/1 row/3.96mm Pitch Vertical Male Pin header	JST	B4P-VH
1	J140	16 pins/2 rows/2.54mm Pitch Vertical Male IDC	Molex	87256-1611
1	J130	34 pins/2 rows/2.54mm Pitch Vertical Male IDC	Molex	87256-3411
1	PCB610	TAS5066-5121K6EVM Printet Circuit Board	Printline	A710-PCB-001(2.00)
1	HEATSINK630	Heatsink with 3 fins (125x35x32mm)	A.K.S.	TIC-HSINK-004(1.00)
6	TPAD630 TPAD631 TPAD632 TPAD633 TPAD634 TPAD635	Thermal pad, 15 MILL SILPAD2000 (11x15.9mm)	Valentin	TIC-TPAD-003(1.00)

Jonas Svendsen

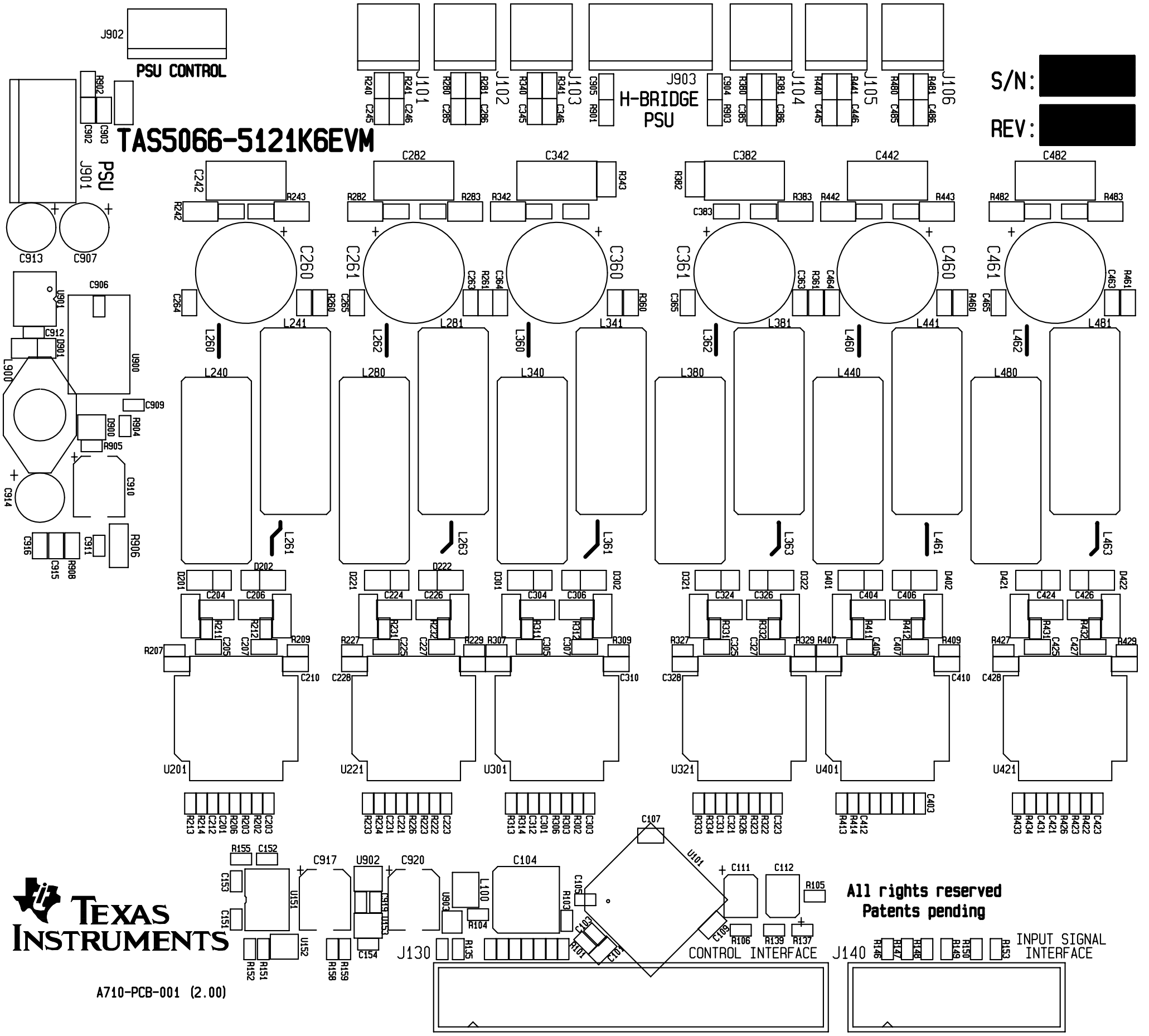
TAS5066-5121K6EVM PCB SPECIFICATION

BOARD IDENTIFICATION:	A710-PCB-001 (2.00)
BOARD TYPE:	DOUBLE-SIDED PLATED-THROUGH BOARD
LAMINATE TYPE:	FR4
LAMINATE THICKNESS:	1.6 mm
COPPER THICKNESS:	70µm (INCL. PLATING EXTERIOR LAYER)
COPPER PLATING OF HOLES:	>25µm
MINIMUM HOLE DIAMETER	0.3 mm
SILKSCREEN COMPONENT SIDE:	WHITE - REMOVE SILKSCREEN FROM SOLDER AREA & PRE-TINNED AREAS
SILKSCREEN SOLDER SIDE:	None
SOLDER MASK COMPONENT SIDE:	GREEN
SOLDER MASK SOLDER SIDE:	GREEN
PROTECTIVE COATING:	SOLDER COATING AND CHEMICAL SILVER ON FREE COPPER
ELECTRICAL TEST:	PCB MUST BE ELECTRICAL TESTED
MANUFACTURED TO:	PERFAG 2E (www.perfag.dk)
APERTURE TABLE:	PERFAG 10A (www.perfag.dk)
BOARD SIZE:	147.3 x 133.6 mm

COMPONENT SIDE	DpS 4947 031204
TI Denmark A710-PCB-001 (2.00)	

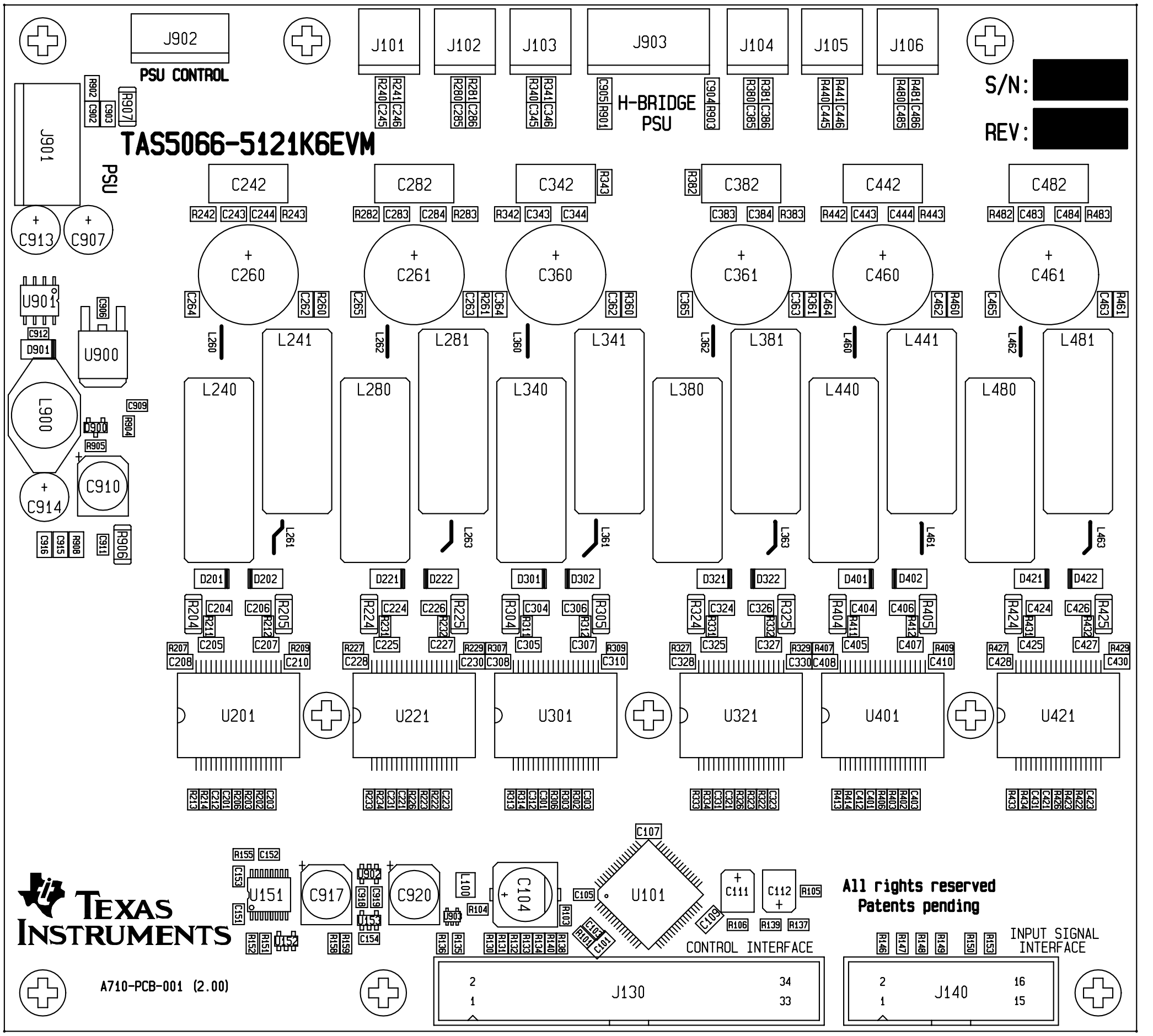


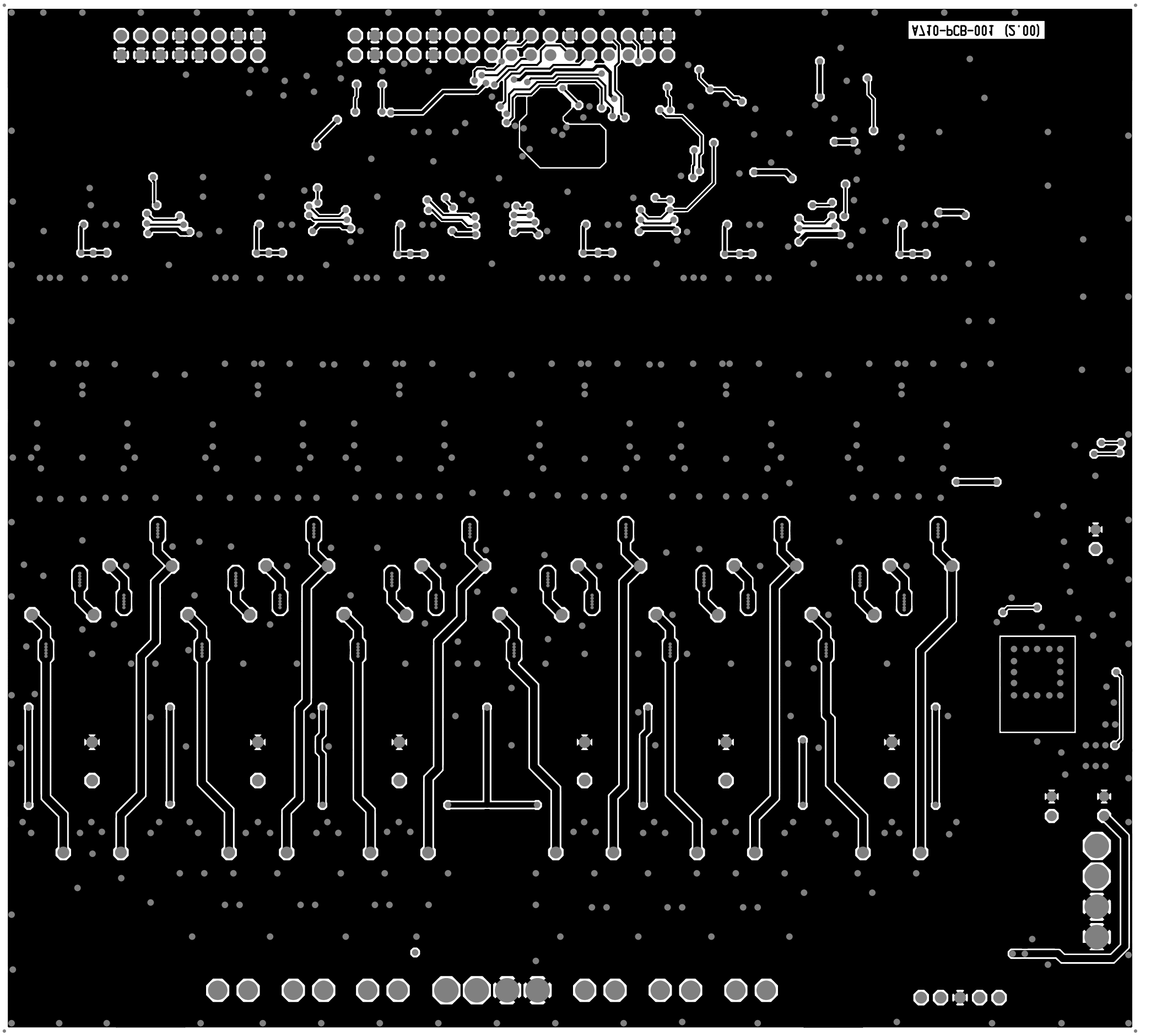
SILKSCREEN COMP	DpS 4947 031204
TI Denmark A710-PCB-001 (2.00)	



A710-PCB-001 (2.00)

COMP. LAYOUT COMP	DpS 4947 031204
TI Denmark A710-PCB-001 (2.00)	

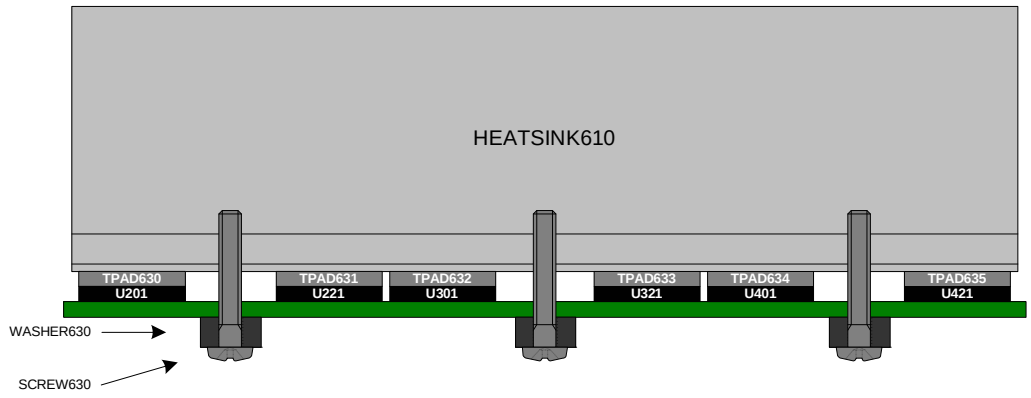




TI Program AM10-PCB-001 (S.00)		
SOLDER SIDE		Dps Data Direction

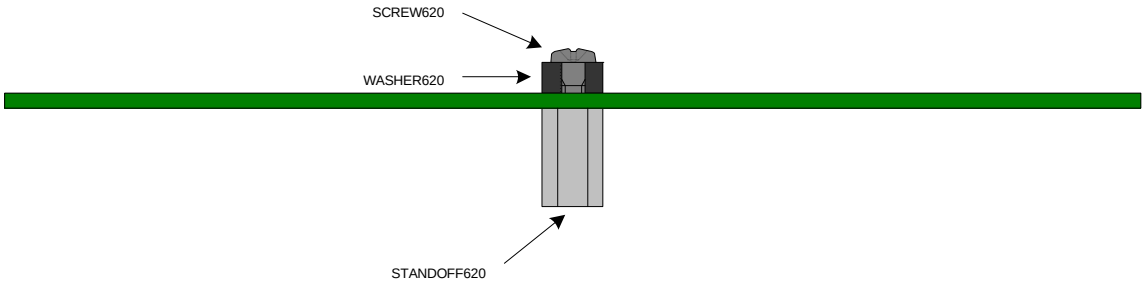
TAS5066-5121K6EVM
Mechanical Design

Jonas Svendsen



TORQUE-LIMITING SCREWDRIVER HAVE TO BE USED DURING ASSEMBLY OF HEAT SINK (TORQUE LIMITED TO 0.3 N*m).

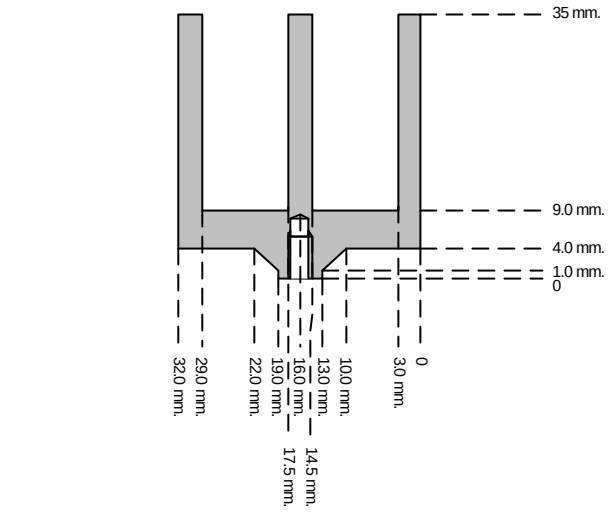
MOUNT STAND OFF'S IN ALL POSSIBLE HOLES OF THE PCB

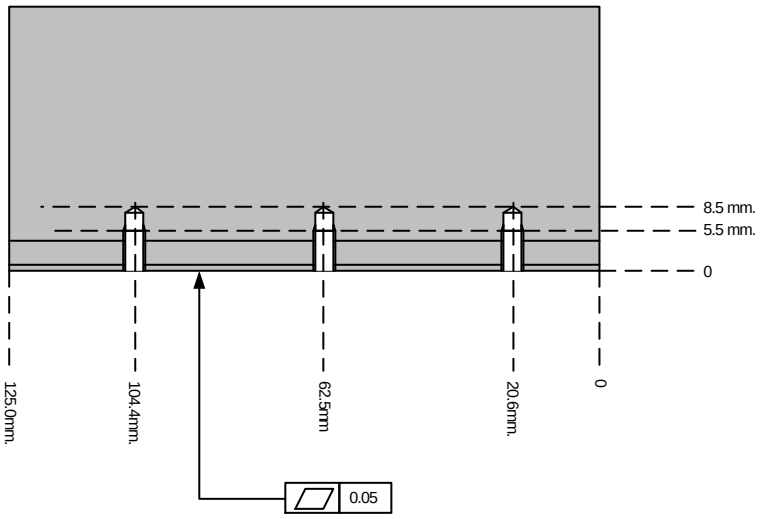


TIC-HSINK-004
Heat Sink with 3 Fins (35 mm.)

23. January 2003
TIC-HSINK-004 (1.00).vsd

Tomas Bruunshuus





MATERIAL: ALUMINIUM

INTERNAL SCREW THREADS: M3

SURFACE: GLASS BLOWED, FREE OF SHARP EDGES

SURFACE TREATMENT: BLACK ANODIZED

TOLERANCES: +/- 0.1mm.

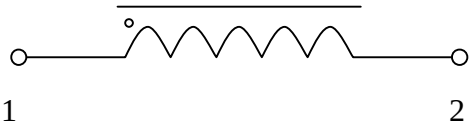
Company Confidential
Inductor Specification

T I

DWG no.: TIC-INDC-003 (1.00)
Renaming of P153-MAG-002(2.00)

Text: 7µH / 8A / 30mΩ

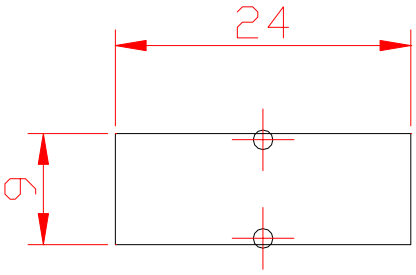
Diagram:



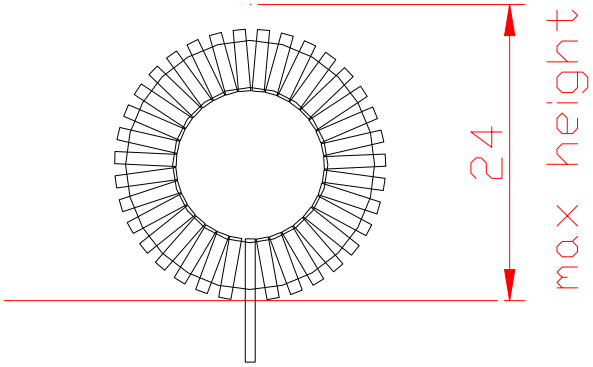
Material: Core: Micrometals T80-2
Wire: ø0.8mm Cu, one layer lacquer, 155°C

Note the picture shows not the actual core

Foot-print top view



Mechanical:



Lead length: 16mm-20mm, stripped and pre-tinned.

Production: Step 1: N1, 35 turns ø0.8mm cu 1L, start 1, end 2
Step 2: bend and strip/pre-tin leads.

Test: Inductance: pin 1 –2 6.5 – 7.5 µH @ 0.1Vrms/10kHz

Release date: 2003-01-10, Tomas Bruunshuus

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