TPS2384 Evaluation Module

This user's guide describes the TPS2384 HPA109 evaluation module (EVM) and contains the EVM schematic, bill of materials, assembly drawing, and top and bottom board layouts.

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1 Related Equipment and Documentation from Texas Instruments

1.1 Related Equipment

The TI EV2300 USB-Based PC Interface Board is required to communicate with the TPS2384 EVM from the EVM's Windows-based control/monitor GUI. This interface EVM can be ordered from the TI website at www.ti.com.

1.2 Related Documentation

- Data Sheet, *TPS2384 Quad Integrated Power Sourcing Equipment Power Manager*, TI Lit. No. SLUS634.
- *EV2300 Evaluation Module Interface Board User's Guide*, TI Lit. No. SLUU159.
- USB Drivers for Windows XP and Windows 2000, SLEC003. (ZIP file, USB drivers for EV2300 board for Windows PC.)
- Software Files for TPS2384EVM, SLVC078. (ZIP file, installation files for TPS2384EVM control GUI.)

2 Introduction

This user's guide describes the setup and operation of the TPS2384 HPA109 evaluation module (EVM). Information and instruction presented throughout this document assumes user familiarity with the TPS2384 and with the IEEE 802.3af Specification for Power Over Ethernet.

3 Hardware Overview

The HPA109 EVM features the TPS2384 made by Texas Instruments. This EVM can be configured as an endpoint power sourcing equipment (PSE) or as a midspan PSE. Four-input and four-output RJ-45 connectors are provided to connect directly to an Ethernet cable.

According to the IEEE 802.3af specification, the PSE can apply power over the data lines or over the spare lines on the Ethernet cable. The HPA109 EVM has been designed with jumpers for applying power in either configuration.

The HPA109 EVM is designed such that the TPS2384 device can operate in either *Auto Mode* or *Power Management Mode*. A graphical user interface (GUI) has also been developed to read and write to the TPS2384 internal registers using the I^2C interface.

4 EVM Operation

4.1 Operation

An external 48-V power supply connected to J3 pin 1 (positive) and J3 pin 3 (negative) is required. JV1 is installed at the factory to apply the 48 volts coming out of the TPS2490 hot-swap controller to the TPS2384 device. JP2 and JP3 also are installed at the factory to give the user the capability to use the S1 reset switch. Depressing S1 generates a logic low signal to the PORB input of the TPS2384 which resets all internal state machines and registers.

The JMS1 jumper is also installed at the factory between pin 1 and pin 2. This sets the Mode Select (MS) to *Auto Mode*. In *Auto Mode*, the TPS2384 automatically discovers, classifies, and powers up IEEE 802.3af-compliant powered devices (PD). Power is applied to the Ethernet port on either the spare pairs or on the data lines of the RJ-45 connector. The TPS2384 EVM has jumper blocks that allow the user to configure the method in which power is applied to the PD. Table 1 can help the user to set the appropriate jumpers depending on the desired power delivery configuration. Although the table shows only the connections for the P1_OUT1 connector, the information applies to all four output RJ-45 connectors.

Table 1. Output RJ-45 Connectors

Insert 48 volts on spare pins of RJ-45 connector, P1_OUT1 (positive on pins 4 and 5 and negative on pins 7 and 8).	
Jumper Block P1P1	Install jumper between the center pin and 1P.
Jumper Block P1N1	Install jumper between the center pin and 1N.
Jumper Block P1PX1	Do not install jumper.
Jumper Block P1NX1	Do not install jumper.
Insert 48 volts on spare pins of RJ-45 connector, P1_OUT1 (positive on pins 7 and 8 and negative on pins 4 and 5).	
Jumper Block P1P1	Install jumper between the center pin and 1N.
Jumper Block P1N1	Install jumper between the center pin and 1P.
Jumper Block P1PX1	Do not install jumper.
Jumper Block P1NX1	Do not install jumper.
Insert 48 volts on data pairs of RJ-45 connector, P1_OUT1 (positive on pins 1 and 2 and negative on pins 3 and 6).	
Jumper Block P1P1	Do not install jumper.
Jumper Block P1N1	Do not install jumper.
Jumper Block P1PX1	Install jumper between center pin and 1P.
Jumper Block P1NX1	Install jumper between center pin and 1N.
Insert 48 volts on data pairs of RJ-45 connector, P1_OUT1 (positive on pins 3 and 6 and negative on pins 1 and 2).	
Jumper Block P1P1	Do not install jumper.
Jumper Block P1N1	Do not install jumper.
Jumper Block P1PX1	Install jumper between center pin and 1N.
Jumper Block P1NX1	Install jumper between center pin and 1P.

While operating in *Auto Mode*, the I^2C interface provided on the TPS2384 EVM can be used to monitor the internal TPS2384 registers. Information such as detection status, port status, classification status, and fault information is available over the I^2C interface.

In *Power Management Mode*, the I^2C interface can be used to manually power up and control the ports. For a complete description of *Power Management Mode* functions, see the TPS2384 data sheet (SLUS634).

4.2 Connectors

J1	I^2C Connector
J2	Alternate Power Extraction Port Connector
J3	Power Input Connector
J4	Allows an external voltage source to be used instead of the VCC_I2C power on the J1 connector.
J5	Connector for an external optocoupler voltage source
J6 (V3.3)	Allows the V3.3 output of the TPS2384 to be used to drive the optocouplers.
J11	Connects PORB from the I2C interface (via the optocoupler) to the TPS2384
J7-J10	Connects the powered port LED to the respective port

4.3 Jumpers

JV1	Connects 48 volts from the output of the hot-swap controller to the TPS2384.
JP1	Connects the CT pin of the TPS2384 to ground. See the TPS2384 data sheet for further information.
JP2	Connects the manual reset switch and RC network to the POR pin of the TPS2384.
JP3	Used to connect a pullup resistor, R25, to the PORB pin of the TPS2384
JSDA_OUT1	Connects the SDA_O pin of the TPS2384 to the I^2C data send optocoupler.
JSDA_IN1	Connects the SDA_I pin of the TPS2384 to the I^2C data receive optocoupler.
JSCL1	Connects the SCL pin of the TPS2384 to the I^2C clock receive optocoupler.
JALT1	Connects the ALT A/B pin of the TPS2384 to ground or to V3.3. See the TPS2384 data sheet for further information.
WDIS1	Connects the WD_DIS pin of the TPS2384 to ground or to V3.3. See the TPS2384 data sheet for further information.
JMS1	Connects the MS pin of the TPS2384 to ground or to V3.3. See the TPS2384 data sheet for further information.

4.4 Test Points

TEST POINTS	DESCRIPTION
TPV10	Test point for monitoring the 10-V internal bias source.
TPV6P3	Test point for monitoring the 6.3-V internal bias source.
TP3.3	Test point for monitoring the 3.3-V voltage source.
TPV2.5	Test point for monitoring the 2.5-V internal bias source.
TPG1, TPG2	Ground test points.
TPSCL1	Test point for monitoring the I^2C clock input to the TPS2384.
TPSDAI1	Test point for monitoring the I^2C data input to the TPS2384.
TPSDAO1	Test point for monitoring the I^2C data output from the TPS2384.
TPCINT1, TPCINT2, TPCINT3, TPCINT4	Test points for monitoring the voltage ramp on the A/D integration capacitors for each port. These are high-impedance inputs, and performance may be affected by any additional impedance. It is recommended that a low-capacitance/FET input buffer be used when monitoring these test points.
TPPORB1	Test point for monitoring the status of the PORB input to the TPS2384.
TPINT1	Test point for monitoring the INTB output of the TPS2384.
TPSYN1	Test point for monitoring the SYN pin of the TPS2384.
TPCT1	Test point for monitoring the CT input pin to the TPS2384. This is a high impedance input and performance may be affected by any additional impedance. It is recommended that a low-capacitance/FET input buffer be used when monitoring this test point.
TPWD1	Test point for monitoring the WD_DIS input pin to the TPS2384.
TPAC_HI1	Test point for monitoring the AC_HI output of the TPS2384.
TPAC_LO1	Test point for monitoring the AC_LO output of the TPS2384.

4.5 I²C Interface

The I²C interface on the TPS2384 EVM can be used to read and write to the TPS2384 internal registers. For simplicity, an EVM available from Texas Instruments, the EV2300, can be used to connect the USB port of a personal computer (PC) to the I²C interface of the TPS2384 EVM. A graphical user interface (GUI) also has been developed specifically for the TPS2384 EVM. Section 5 of this document describes the connections and operation of the TPS2384 GUI.

For I²C operation, an external 3.3-V supply must be connected to J3 pin 4 and referenced to J3 pin 3, or J6 must be installed. Also, the jumpers JSDA_OUT1, JSDA_IN1, and JSCL1 must be installed.

Ensure that S2 address select switch is set for I²C binary address of 00001 (S2-1 closed and S2-2, S2-3, S2-4, and S2-5 open).

5 TPS2384 Graphical User Interface Operation

This section describes the setup and operation of the TPS2384 GUI for the HPA109 evaluation module. Two files, TPS2384EVM and TPS2384EVM.exe, must be downloaded from the TI Web site. These files are located at http://focus.ti.com/docs/toolsw/folders/print/tps2384evm.html#supportsoftware. Click on the word *Zip* beneath Product Description, Software Support at this location.

5.1 EV2300 Software

The EV2300 software is available for download from the TI Web site at the following location:

http://focus.ti.com/docs/toolsw/folders/print/ev2300.html

5.2 Connecting the PC to the EV2300

Using a standard USB cable, connect the USB port of the PC to the USB port of the EV2300.

5.3 Connecting the EV2300 to the HPA109 EVM

Using the wiring assembly provided with the EV2300, connect one end to the I²C port of the EV2300. Connect the other end to the I²C interface connector of the HPA109 EVM as follows:

- Red wire to J1 pin 1
- White wire to J1 pin 3
- Brown wire to J1 pin 5
- Black wire to J1 pin 8

5.4 Starting the GUI

After installing all the necessary files for both the EV2300 and the HPA109, start the TPS2384 GUI by executing the TPS2384EVM.exe file.

5.5 GUI Operation for TPS2384 Auto Mode (JMS1 Jumper Connected Between Pin 1 and Pin 2)

On the TPS2384 GUI, click on the *Start access* button. The *Enable Auto Read* button should be selected (this is the default mode). As a point of reference, a screen shot of the TPS2384 GUI is shown in Figure 1. The GUI register numbers shown on the GUI screen correspond to the register numbers on the TPS2384 data sheet.

- Register *0* shows the Chip ID and Chip Revision.
- Register *100* shows the classification and port status for each of the four ports. This register also shows the *Discovery Fail* and *Function Done* for each port.
- Register *101* shows the *Detect Status* for each of the four ports along with the *AtoD Active* status of each port.
- Registers 110 to 1101 show the raw data and converted data for resistance, voltage, and current. Temperature data is not sampled in Auto Mode. Temperature data is only available in Power Management Mode.

In *Auto Mode*, only the read registers within the TPS2384 device are accessible.

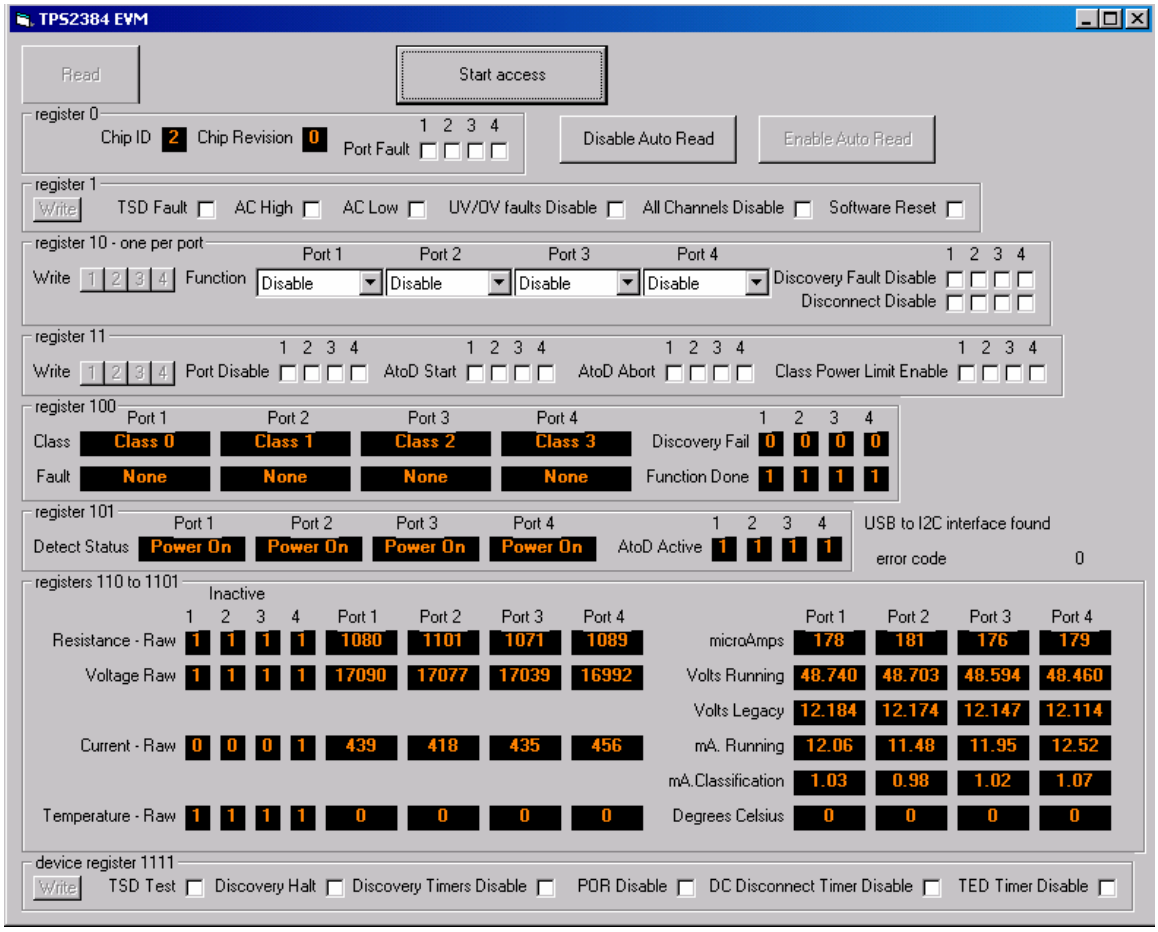

Figure 1. Screen Shot of TPS2384 GUI – *Enable Auto Read* **Selected**

5.6 GUI Operation for TPS2384 Power Management Mode (JMS1 Jumper Connected Between Pin 2 and Pin 3)

After starting the TPS2384 GUI, click on the *Start access* button. This allows the GUI to report the TPS2384 status resisters. In order to control the TPS2384 write registers, depress the *Disable Auto Read* button.

Select the desired function in register *10* by selecting the pulldown arrow button under the desired port. The default function is shown as Disable (see Figure 2). All the functions appearing when the pulldown arrow button is selected correspond to the functions shown in the TPS2384 data sheet for the individual Port Write Control Register. For a description of each of the functions, see the *Power Management Mode* section of the TPS2384 data sheet (SLUS634).

After selecting the desired function, depress the corresponding port number on the left side of the GUI in the register *10* section. This writes the command into the TPS2384 register and thereby performs that operation.

To view the status, depress the *Read* button on the top left of the GUI. This is a one-time event that takes a snapshot of the TPS2384 status registers. For a continuous update of the status registers, depress the *Enable Auto Read* button on the GUI.

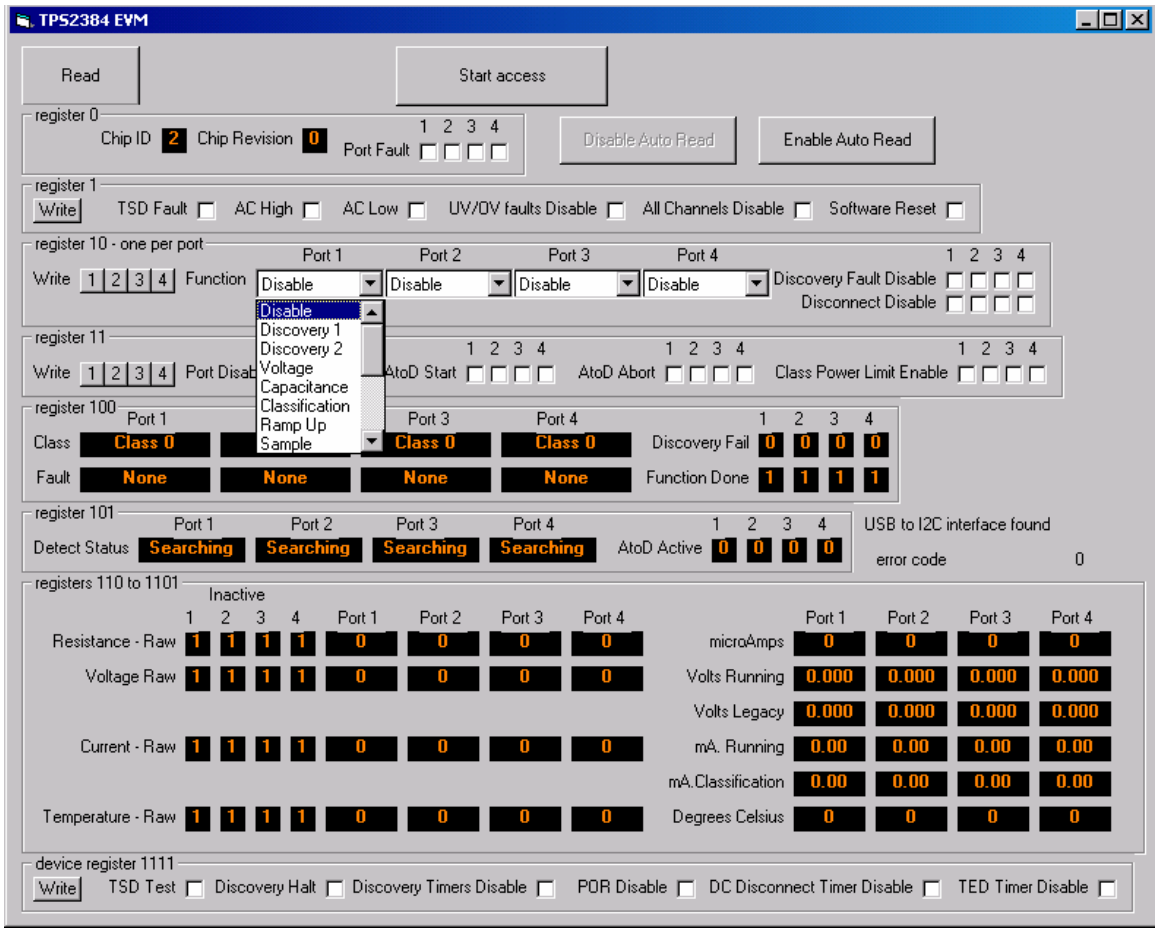

Figure 2. Screen Shot of the GUI – *Port Function Pulldown* **Selected**

6 Bill of Materials

Table 2 contains the bill of materials for the TPS2384 HPA109 evaluation module.

Table 2. HPA109 Bill of Materials

Count	Ref Des	Value	Size	MFR	Part Number	Description (1) (2) (3) (4) (5)
4	1GND1, 2GND1 3GND1, 4GND1	GND	SMD	Keystone	5016	Test Point, SM, 0.150 x 0.090"
7	C1, C7, C8, C10, C11, C16, C20	0.1 µF	1206	Vishay	Std	Capacitor, Ceramic, 0.1-µF, 100-V
4	C12, C13, C14, C15	0.027 µF	SM	Panasonic	ECHU1H273GX5	Capacitor, Film Chip, .027-µF, 50V, 2%
3	C17, C18, C19	0.1 µF	805	Vishay	Std	Capacitor, Ceramic, 10V, X7R, 10%
1	C2	0.1 µF	805	Vishay	Std	Capacitor, Ceramic, 0.1-µF, 6.3-V, X7R, 20%
4	C1A1,C2A1, C3A1, C4A1	0.22 µF	1210	TDK	C3225X7R2A224K	Capacitor, Ceramic, 0.22 µF, 100V, X7R, 10%
1	C3	0.1 µF	1206	Vishay	Std	Capacitor, Ceramic, 0.1-µF, 6.3V, X7R, 20%
1	C4	220 µF	SMD	Panasonic	EEVFK2A221M	Capacitor, Aluminum, 220 µF, 100V, 20%
1	C5	1 µF	805	Vishay	Std	Capacitor, Ceramic, 1-µF, 50-V

(1) These assemblies are ESD sensitive, ESD precautions shall be observed.
(2) These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.
(3) These assemblies must comply with workmanship standards IPC-A-610 Class 2.
(4) Ref designators marked with an asterisk ('**') cannot be substituted. All other components can be substituted with equivalent MFG's components.
(5) Add 6 rubber bumpers to the bottom side of the board.

Table 2. HPA109 Bill of Materials (continued)

Count	Ref Des	Value	Size	MFR	Part Number	Description (1) (2) (3) (4) (5)
1	C6	68 µF	SMD	Panasonic		EEV-FK2A680Q Capacitor, Aluminum, SM, 68 µF, 100-V
1	C9	220 pF	805	Std	Std	Capacitor, Ceramic, 220 pF, 100V, C0G, 1%
8	CF1, CF2, CF5, CF6, CF9, CF10, CF13, CF14	1000 pF	1808	TDK	C4520X7R3D102K	Capacitor, Ceramic, 1000-pF, 200-V, X7R, 10%
8	CF3, CF4, CF7, CF8, CF11, CF12, CF15, CF16	0.01 µF	805	Std	Std	Capacitor, Ceramic, 0.01 µF, 100V, X7R, 20%
8	D13, D14, D15, D16, D21, D22, D23, D24		SOD-323	Protek Devices	GBLC03C	Diode, TVS, 19 Clamping Voltage, 350W
4	D25, D26, D27, D28			ON Semi	1SMB5932BT3	Zener Diode, 20V, 3W
4	D29, D30, D31, D32		SMA	Littelfuse	SMA10A	Diode, Transient Voltage Suppressor, 400W, 100V
6	D3, D7, D17, D18, D19, D20		SMD	Panasonic	LN1371G	Diode, LED, Green, 20-mA, 0.9-mcd
1	D33		SMA	Diodes Inc.	1SMA5919BT3	Diode, Zener
1	D4		SMA	Vishay	SMAJ58A	Diode, Switching, 58-V, 400W
1	D8		SMA	Diodes Inc.	SMA12A	Diode, Zener,12-V, 1W, 400W
8	DAC1, DAC2, DAC4, DAC5, DAC7, DAC8, DAC11, DAC13		SMA	ST	STPS1H100A	Diode, Schottky, 1A, 100V
1	DAC3		SMB	Diodes Inc.	S2B-13	Diodes Rectifier,1.5A 100V
4	DAC6, DAC9, DAC10, DAC12		SMA	Diodes, Inc.	ES2B/A	Diode, Schottky, 2A, 100V
4	F1, F2, F3, F4		TH	Raychem	RXE090	Polyswitch, 0.47 Ω Max, 40 A Max, 72 V Max
1	J1		TH	Weidmüller	1793840000	Header, 8-pin, 150 mil spacing
1	J1 Socket			Weidmüller	1798900000	Header, 8-pin, Socket, 150 mil spacing
1	J2		TH	Sullins	PTC36SAAN	Header, 8-pin, 100 mil spacing
1	J3		TH	Weidmüller	1793830000	Header, 6-pin, 150 mil spacing
1	J3 Socket			Weidmüller	1798890000	Header, 6-pin, Socket, 150 mil spacing
11	J4, J5, J6, J7, J8, J9, J10, J11, JP1, JP2, JP3		TH	Sullins	PTC36SAAN	Header, 2-pin, 100 mil spacing Header, 2-pin, 100 mil spacing
3	JALT1, WDIS1,JMS1		TH	Sullins	PTC36SAAN	Header, 3-pin, 100 mil spacing
4	JSCL1, JSDA_IN1, JSDA_OUT1, JV1		TH	Sullins	PTC36SAAN	Header, 2-pin, 100 mil spacing
4	L1, L2, L3, L4		SMD	Coilcraft	TTDLF2500	Inductor, 2 Lines, 0.500A, 5 µH
8	P1_IN1, P1_OUT1, P2_IN1, P2_OUT1, P3_IN1, P3_OUT1, P4_IN1, P4_OUT1	RJ-45	TH	AMP	556416-1	Connector, Jack, Modular, 8 POS
16	P1N1, P1NX1, P1P1, P1PX1, P2N1, P2NX1, P2P1, P2PX1, P3N1, P3NX1, P3P1, P3PX1, P4N1, P4NX1, P4P1, P4PX1		TH	Sullins	PTC36SAAN	Header, 3-pin, 100 mil spacing
1	Q1		D2PAK	IR	IRF540NS	Transistor, NFET, 100V, 33A, 44 mΩ
1	Q2	BSS119	SOT23		BSS119E6327	MOSFET, N-ch, 100-V, .17-A, zz-mΩ
1	Q3		SOT23	Fairchild	FDV301N	MOSFET, Nch,25V, 220-mA, 5 Ω
1	R1	7.15 kΩ	805	Std	Std	Resistor, Chip, 7.15 kΩ, 1/10-W, 5%
3	R11, R13, R14	2 kΩ	805	Std	Std	Resistor, Chip, 2 kΩ, 1/10-W, 5%
4	R35, R36, R37, R38	10 kΩ	805	Std	Std	Resistor, Chip, 10 kΩ, 1/10-W, 5%
2	R15, R21	1kΩ	805	Std	Std	Resistor, Chip, 1 kΩ, 1/10-W, 5%
1	R18	0.01 Ω	2512	IRC	LCR-LRF2512-01-R010-F	Resistor, Metal Strip, 0.01 Ω, 2 W, 1%

Table 2. HPA109 Bill of Materials (continued)

Count	Ref Des	Value	Size	MFR	Part Number	Description (1) (2) (3) (4) (5)
1	R19	0.0 Ω	805	Std	Std	Resistor, Chip, 0.0 Ω, 1/10-W, 5%
3	R2, R3, R4	200 Ω	805	Std	Std	Resistor, Chip, 200-Ω, 1/10-W, 5%
1	R20	330 Ω	805	Std	Std	Resistor, Chip, 330-Ω, 1/10-W, 5%
1	R22	100 Ω	805	Std	Std	Resistor, Chip, 100-Ω, 1/10-W, 5%
1	R25	10 kΩ	805	Std	Std	Resistor, Chip, 10 kΩ 1/10-W, 5%
1	R26	124 kΩ	805	Std	Std	Resistor, Chip,124 kΩ, 1/10W, 1%
1	R5	69.8 kΩ	805	Std	Std	Resistor, Chip, 69.8K-Ohms, 1/10-W, 1%
4	R6, R9, R12, R17	3.3 kΩ	805	Std	Std	Resistor, Chip, 3.3 kΩ, 1/10W, 5%
1	R7	187 kΩ	805	Std	Std	Resistor, Chip, 187 kΩ, 1/10-W, 5%
1	R8	100 kΩ	805	Std	Std	Resistor, Chip, 100 kΩ, 1/10W, 5%
4	RAC1, RAC2, RAC3, RAC4	7.5 kΩ	805	Std	Std	Resistor, Chip, 7.5 kΩ, 1/10W, 5%
16	RF1, RF2, RF3, RF4, RF5, RF6, RF7, RF8, RF9, RF10, RF11, RF12, RF13, RF14, RF15, RF16	75 Ω	603	Std	Std	Resistor, Chip, 75 Ω, 1/16W, 5%
1	S1		SMD	C & K	KT11P2JM	Switch, SPST, PB Momentary, Sealed Washable
1	S2		TH	Grayhill	76SB06S	Switch, 6-pole DIP, Raised Rocker
4	T1, T2, T3, T4		SMD	Pulse	H2019	Xfmr, Center-tapped, Voice Over IP
20	TP3.3, TPAC_HI1, TPAC_LO1, TPCINT1, TPCINT2, TPCINT3, TPCINT4, TPCT1, TPG1, TPG2, TPINT1, TPPORB1, TPSCL1, TPSDAI1, TPSDAO1, TPSYN1, TPV10, TPV6P3, TPWD1,TVP2.5	G10	TH	Keystone	5012	Test Point, White, O.062 Hole
1	U1		SO-8	NEC	PS9821-1	IC, Optocoupler, Single Open Collector Out Put
1	U3		SO-8	NEC	PS8821-1	IC, Optocoupler, Single Open Collector Out Put
1	U2		SO-8	NEC	PS8821-2	IC, Optocoupler, Dual Open Collector Out Put
1	U4		DGS10	TI	TPS2490DGS	IC, TPS2490DGS
1	U5		SO14	TI	SN74LVC06AD	IC, High-Speed CMOS Logic Hex Inverting Schmitt Trigger
1	U6		PQFQ-64	TI	TPS2384PAP	IC, Quad Ethernet Power Sourcing
1	–			Any	HPA109B	PCB, 9.3 In x 4.9 In x 0.062 In
						Shunt

7 EVM Schematic and Layouts

The EVM schematic and top and bottom board layouts are appended.

Title	TPS2384 4 PORT CONTROLLER		
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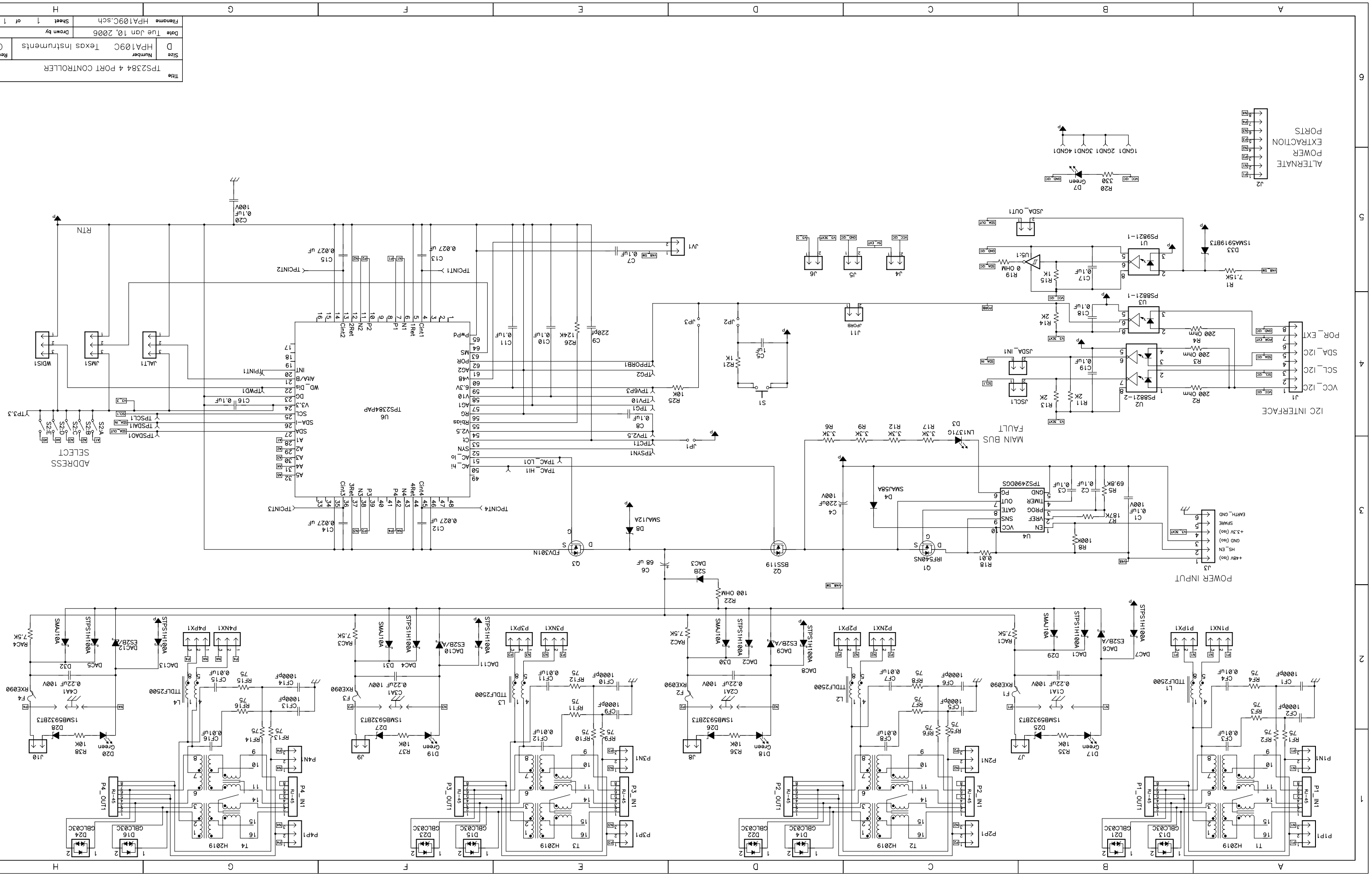
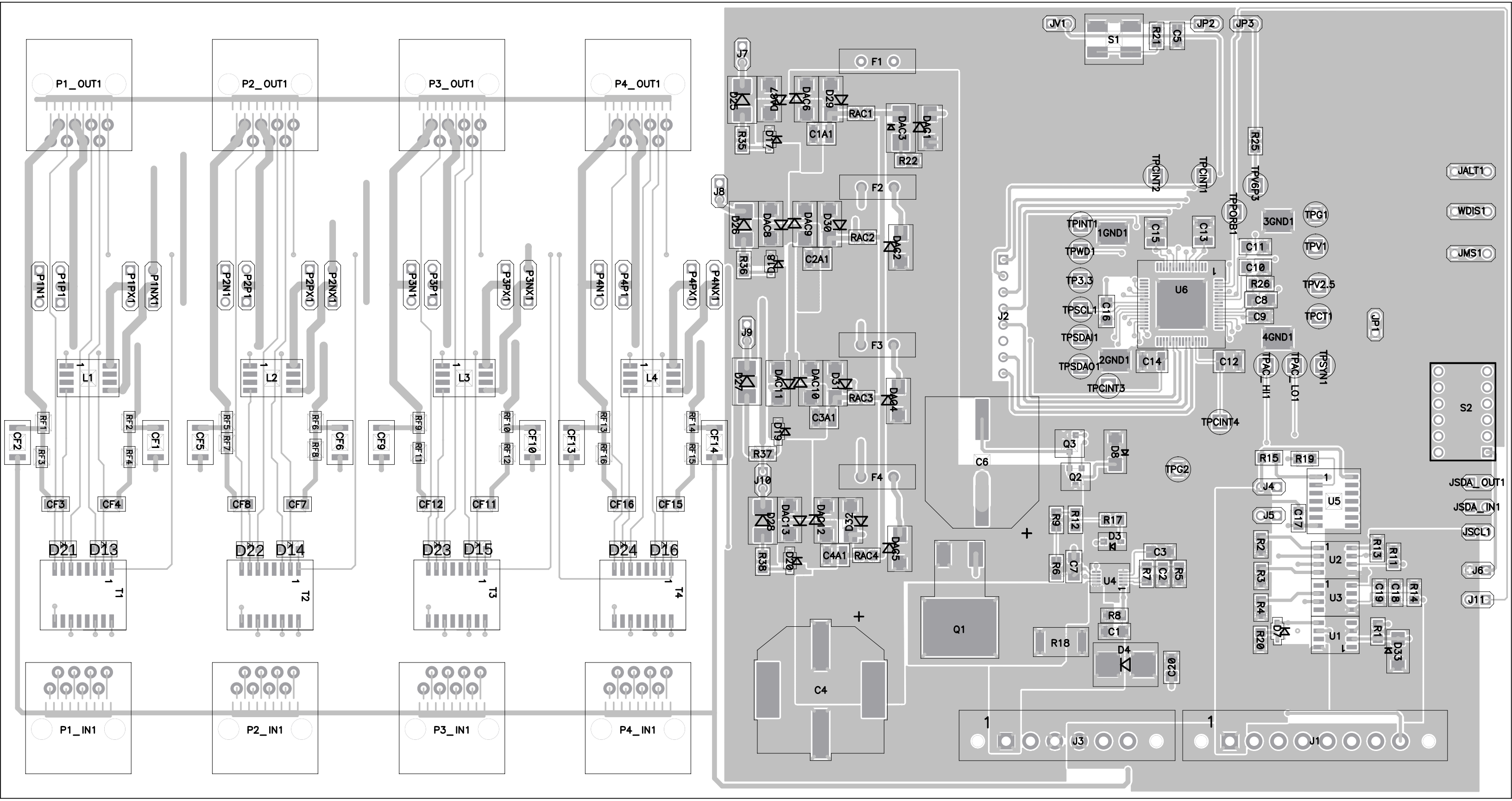
Date Tue Jun 10, 2006		Drawn by	
Filename HPA109C.sch		Sheet 1 of 1	





LAYER 1 HPA109 REV.B TOP ASSY

LAYER 2

SILK 2

Evaluation Board/Kit Important Notice

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

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FCC Warning

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 44 V to 57 V and the output voltage range of 44 V to 57 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 85°C. The EVM is designed to operate properly with certain components above 85°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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