

## Introduction

The IPM6220A is a highly integrated power management IC that provides regulation and protection for five system voltages required in high-performance notebook PCs. The IC integrates two step-down fixed frequency PWM controllers, one step-up PWM controller and two linear regulators and operates from a battery input of 5.6–24VDC. All MOSFET drivers, output voltage and current monitoring and protection circuitry is included in a single 24-lead SSOP package.

The IPM6220A and the evaluation board reference design provide a flexible, efficient, cost effective and compact solution for laptop computers and other portable equipments. Using the output ON/OFF controls: SDWNALL, SDWN1 (+5V), and SDWN2 (+3.3V), various low power states can be enabled for increased battery life and run time. State of health information is provided with the 'PGOOD', open drain output, which when pulled high indicates that all outputs (except the +12V) are within  $\pm 10\%$  of their nominal output levels and that the +12V is within its overvoltage and undervoltage thresholds.

## Quick Start Evaluation

### Circuit Setup

The IPM6220EVAL board is built for easy evaluation using standard laboratory equipment. Consult Table 1 for the range of input and output voltages and currents.

### Set up switch SW1 and jumper, JP1

The IPM6220EVAL board is typically shipped with the jumper installed and SW1 set with all outputs enabled.

JP1 enables the red/green LED to indicate the state of PGOOD. A green light indicates PGOOD is asserted. Remove JP1 only if efficiency measurements are being taken, especially at light loads.

SW1 controls the enabling of the outputs. Figure 1 and Table 2 describe the enabling options.

### Connect the Input Power Supply

With the input power supply turned off, connect it to the  $V_{IN}$  and GND turrets on the top of the board.

### Connect the Output Loads

Connect electronic or other loads to the outputs +5V, +3.3V, +12V, 3.3V always and 5V always, as required.

## Operation

### Apply Power to the Board

With the input power supply adjusted between 5.6V and 24V, turn the power supply on. The green, PGOOD, LED should illuminate. If the red LED is on, cycle the 'SDWNALL' switch down, then up.

### Examine Start-up Waveforms

The enabled switcher outputs should come up according to their soft start capacitor values. The ramp up time for the outputs may be observed on the test points provided, as well as the ramp up time on the soft-start / enable pins, SDWN1 and SDWN2. Typical start-up waveforms are shown in Figure 2.

With the 3.3V and 5V outputs enabled, the green LED will illuminate when both outputs are within 12% of their nominal value. If one, or both, of these outputs are disabled, the LED will be red, indicating the output(s) is not within 12% of the nominal. The 12V boost converter may be 'artificially' shut down without affecting the LED. This is done with SW1, SDWN3, in the 'up' position, connecting the 5V ALWAYS to the feedback pin, VSEN3.

Figure 7 shows a schematic diagram of the IPM6220 Evaluation board.

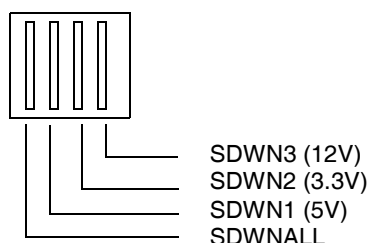
**TABLE 1. EVALUATION BOARD INPUT / OUTPUTS**

PARAMETER	MIN VOLTAGE	TYP VOLTAGE	MAX VOLTAGE	MIN CURRENT	TYP CURRENT	MAX CURRENT
Vin	5.6	12	24	(1)	(1)	(1)
+5V	4.9	5.0	5.1	0	3	5
+3.3V	3.234	3.3	3.366	0	3	5
+12V	11.76 -2.0%	12 set @ 9-15	12.24 +2.0%	0	100mA	200mA
+5V Always	4.9	5.0	5.1	0	10mA	50mA (2)
+3.3V Always	3.234	3.3	3.366	0	10mA	50mA (2)

**NOTES:**

1. Dependent on Vin and output loading
2. Maximum combined currents of +5V Always and +3.3V Always is 50mA

Figure 1 shows the switch position definition of switch, SW1.

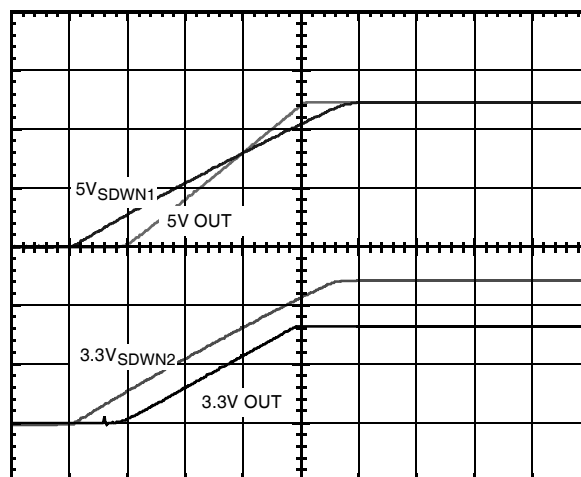


**FIGURE 1. SWITCH S1 POSITION DEFINITIONS**

Table 2 shows the function of each of the switch positions.

**TABLE 2. SWITCH S1 FUNCTIONS**

SWITCH POS	SW UP/DOWN	FUNCTION
SDWNALL	UP	Enables all other SW positions
SDWNALL	DOWN	All outputs shutdown
SDWN1 (+5V)	UP	+5V shutdown
SDWN1 (+5V)	DOWN	+5V on
SDWN2 (+3.3V)	UP	+3.3V shutdown
SDWN2 (+3.3V)	DOWN	+3.3V on
SDWN3 (+12V)	UP	+12V shutdown
SDWN2 (+12V)	DOWN	+12V on



**FIGURE 2. OUTPUT VOLTAGES AND SOFT-START. 2V/DIV, 5ms/DIV, C16 = C17 = 0.022uF**

## IPM6220A Reference Design(s)

### Evaluation Board Circuit Description

The basic circuits on the evaluation board are:

- two buck converters with synchronous rectifiers (+5V and +3.3V outputs)
- a boost converter (+12V output)
- two internal linear regulators (+3.3 always and +5.0 always)
- soft-start, shutdown and status (PGOOD)

Table 3 shows optional component configurations for various output currents. The Eval1 board is normally configured for 5A outputs.

During the initial start-up, the capacitances on the five output voltages must be charged. Depending on the input power impedance and how fast it transitions, much of this required energy may come from the input capacitor, C4. Therefore,

## Application Note AN1005

one constraint on the soft-start time is that it should be longer than the input voltage transistion otherwise, during start up, the input capacitor voltage may 'sag' causing an

input undervoltage shutdown. Practically, this is only a concern when using a bench power supply which may take more than 50ms to reach its voltage set point.

**TABLE 3. TYPICAL COMPONENTS FOR VARIOUS OUTPUT CURRENTS**

COMPONENT	REF DESIG	2A	3A	4A	5A
MOSFETS	Q2,Q3,Q4,Q5	HUF76105SK8	HUF76112SK8	HUF76112SK8	HUF76112SK8
INPUT CAPACITOR	C4,INPUT CAPACITOR	N/A	N/A	1) SANYO 25SP56M	1) SANYO 25SP56M
INPUT CAPACITORS	C6, C10 INPUT CAPACITORS	1)TAIYO YUDEN, TMK325F106ZH	1)TAIYO YUDEN, TMK325F106ZH	1)TAIYO YUDEN, TMK325F106ZH	1)TAIYO YUDEN, TMK325F106ZH
INDUCTOR	L1,L2	1) TOKO 892NBS-220M 2) COILCRAFT DO3316P-223 22uH	1) TOKO 892NAS-150M 2) COILCRAFT DO3316P-153 15uH	1) PANASONIC ETQ-P6F102HFA 2) ABC TAIWAN ELECTRONICS SS1208100MSB	1) PANASONIC ETQ-P6F102HFA 2) ABC TAIWAN ELECTRONICS
3.3V OUTPUT CAPACITORS	C13,C22	1) C22 ONLY SANYO 4TPC150M	1) SANYO 4TPC150M	1) SANYO 4TPC150M	1) SANYO 6TPB330MM
5V OUTPUT CAPS	C21,C32	1) C32 ONLY SANYO 6TPB150M	1) C32 AND C21 ONLY SANYO 6TPB150M	1) C32 AND C21 ONLY SANYO 6TPB150M	1) C32 AND C21 ONLY SANYO 6TPB330M

Efficiency curves for the 5V and 3.3V outputs, up to 5A, are shown in Figures 3 and 4. Figure 5 shows typical regulation performance for the 12V boost output.

Figure 6 shows the out-of-phase switching waveforms for the 3.3V and 5V outputs. Also shown is the resulting inductor current waveforms for output currents of 5A.

The schematic diagram in Figure 7 shows the complete schematic implemented on the Eval1 board. Various optional components such as input and output capacitors are shown

on the schematic but not all are populated on the Eval1 board. This is done to allow flexibility for customers to evaluate the design with their preferred parts.

Table 4 lists the bill of materials for the evaluation board.

The evaluation design is implemented in a 2-ounce, 4-layer printed circuit board. The board and the individual layers are shown on the last pages of the applications note. Wherever needed to reduce layout parasitics, via-in-pad (VIP) layout techniques were used.

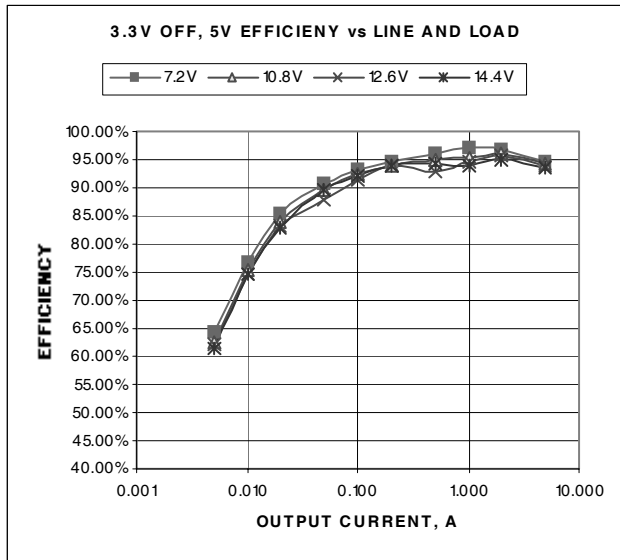


FIGURE 3. 5V EFFICIENCY

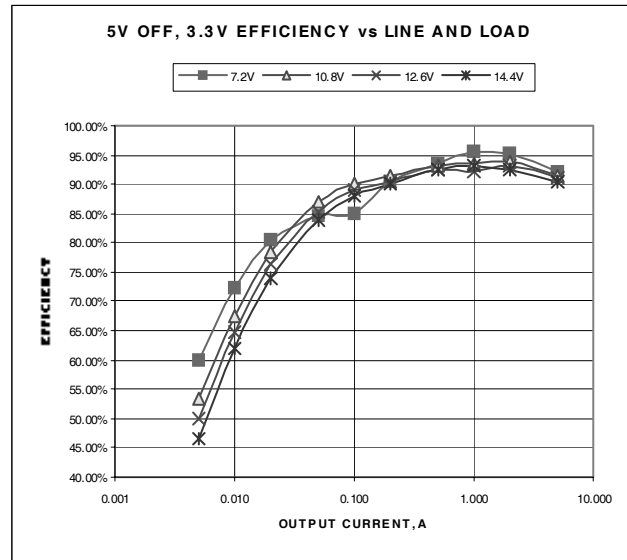


FIGURE 4. 3.3V EFFICIENCY

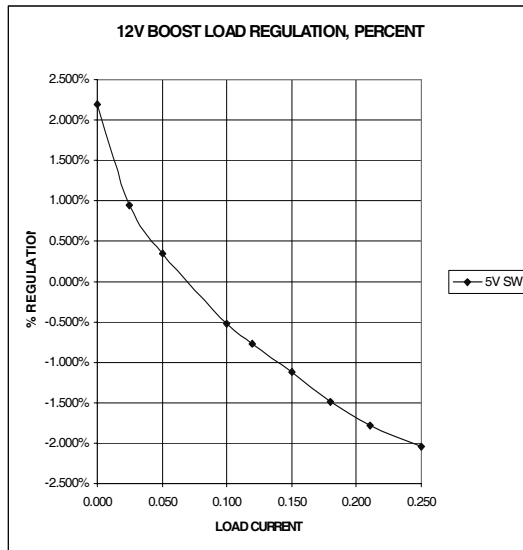


FIGURE 5. 12V REGULATION

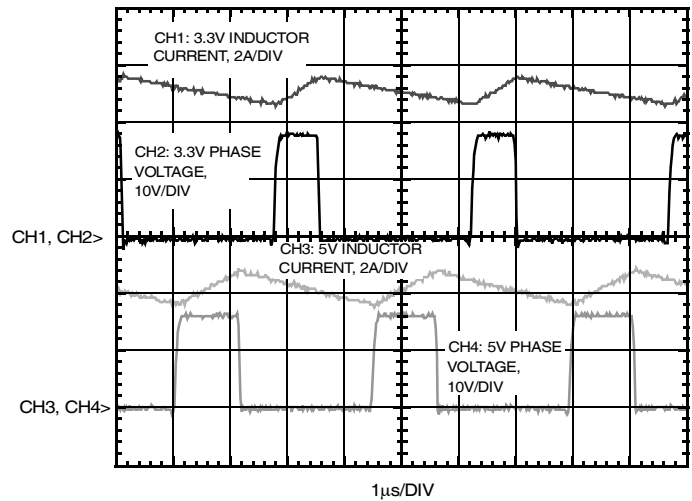
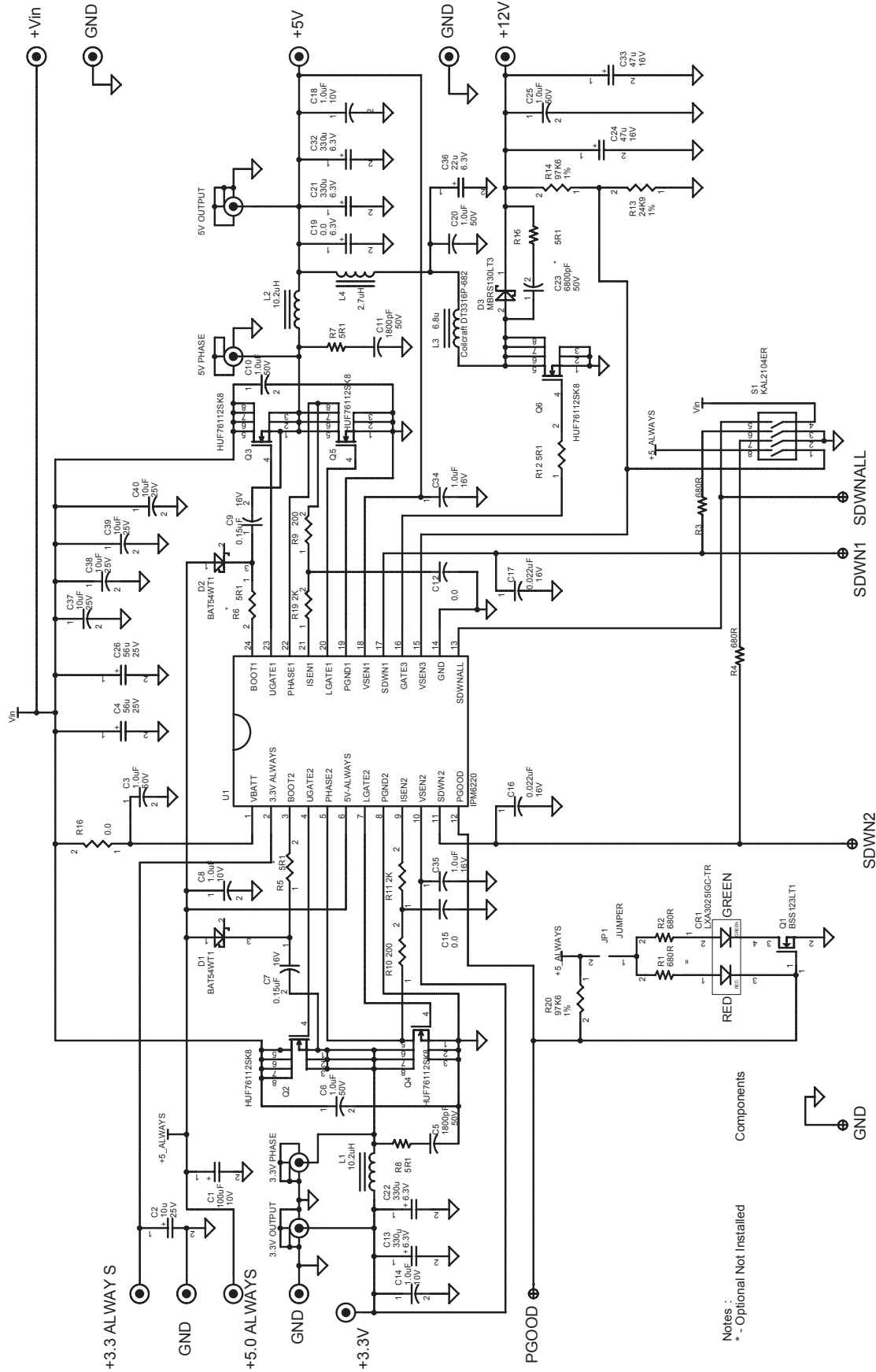


FIGURE 6. SWITCHING WAVEFORMS, OUT OF PHASE OPERATION



**FIGURE 7. IPM6220 EVALUATION BOARD, REV\_C**

## Application Note AN1005

**TABLE 4. EVALUATION BOARD BILL OF MATERIALS**

Item	Qty	Reference	Value	Part Number	Voltage	Package
1	1	CR1	LXA3025IGC-TR			SMT/3MM/2.3MM
2	1	C1	100uF	KEMET T494D686(1)016AS	10V	SM/CT_7343_12
3	1	C2	10u	AVXTPSC106K025RO500	25	SM/CT_6032_12
4	5	C3, C6, C10, C20, C25	1.0uF	KEMET C1812C105K5RAC	50V	SM/C_1812
5	1	C4	56u	OSCON 25SP56M	25V	
6	2	C5, C11	1800pF	KEMET C0805C102K5RAC	50V	SM/C_0805
7	2	C9, C7	0.15uF	KEMET C1206C154K4RAC	16V	SM/C_1206
8	3	C8, C14, C18	1.0yF	KEMET C1206C105K8RAC	10V	SM/C_1206
9	0	C15, C12	100p	KEMET C0805c101k5GAC		SM/C_0805
10	4	C13, C21, C22, C32	330u	AVX6TPB330M	6.3V	SM/CT_7343_12
11	2	C17, C16	0.022uF	KEMET C1206C223K4RAC	16V	SM/C_1206
12	1	C19	0	AVX6TPB330M	6.3V	SM/CT_7343_12
13	1	C23	6800pF	KEMET C1206C68K5GAC	50V	SM/C_1206
14	2	C24, C33	47u	KEMET T494D76(1)016AS	16V	SM/CT_7343_12
15	2	C35, C34	1.0uF	KEMET C0805C105K4RAC	16V	SM/C_0805
16	1	C36	22u	6APA22M	6.3V	SM/CT_7343_12
17	2	D2, D1	BAT54WT1	Motorola BAT54WT1		SM/SOT23_123
18	1	D3	MBRS130LT3	Motorola MBRS130LT3		SM/_SMB
19	1	JP1	JUMPER			
20	15	TP1, TP2, TP3, TP4, TP7, J1, J2, J3, J4, J5, J6, J7, J8, J9, J10	1502TL-2	Keystone 1502TL-2		
21	2	L1, L2	10.2uH	Panasonic ETQP6F102HFA		HP/IND_SMT_ETQP6
22	1	L3	6.8u	Coilcraft DT3316P-682		HP/IND_SMT_DT3316SR
23	1	L4	2.7uH	API Delvan DN2530		AX/.300S.100/.028
24	1	Q1	BSS123LT1			SM/SOT23_123
25	5	Q2, Q3, Q4, Q5, Q6	HUF76112SK8			SOG.050/8/WG.244/L.200
26	4	R1, R2, R3, R4	680R	0805		SM/R_0805
27	3	R5, R6, R12	5R1	00805		SM/R_0805
28	3	R7, R8, R15	5R1	1206		SM/R_1206
29	2	R9, R10	200	0805		SM/R_0805
30	2	R11, R19	2K	0805		SM/R_0805
31	1	R13	24K9	0805		SM/R_0805
32	2	R14, R20	97K6	0805		SM/R_0805
33	1	R16	0	0805		SM/R_0805
34	1	S1	KAL2104ER	E-Switch KAL2104ER		
35	1	TP5	3.3V PHASE			TP\PROBE-SOCKET
36	1	TP6	5V PHASE			TP\PROBE-SOCKET
37	1	TP8	3.3V OUTPUT			TP\PROBE-SOCKET
38	1	TP9	5V OUTPUT			TP\PROBE-SOCKET
39	1	U1	IPM6220			SSOP_24P

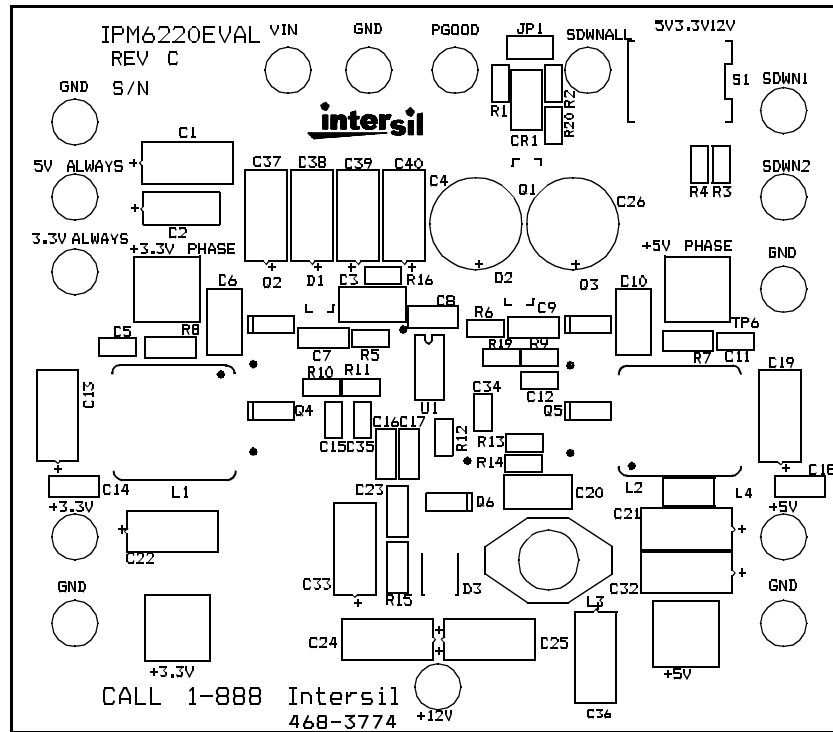


FIGURE 8. SILKSCREEN

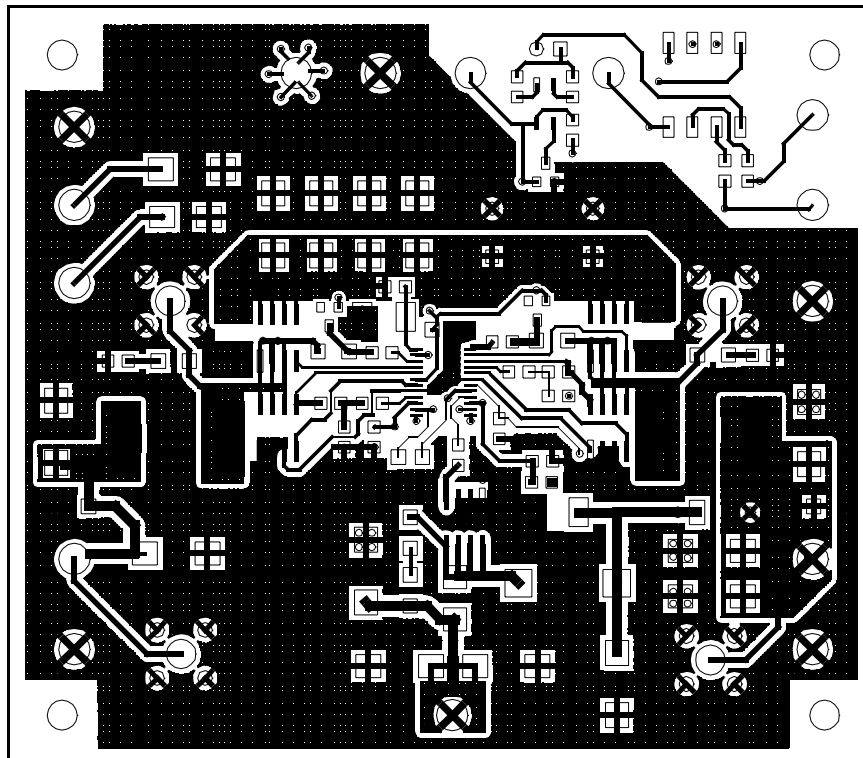
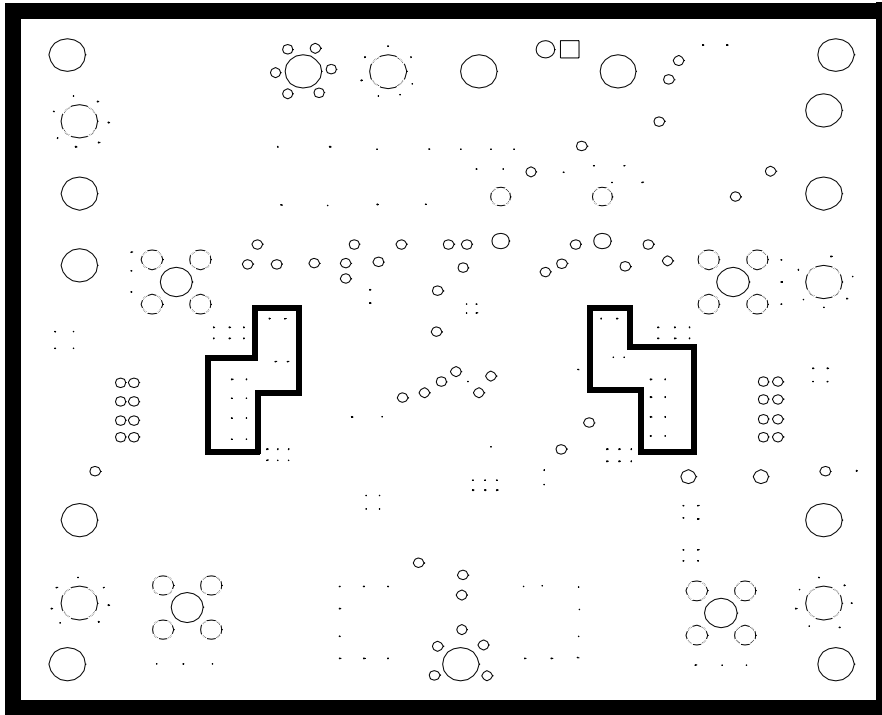
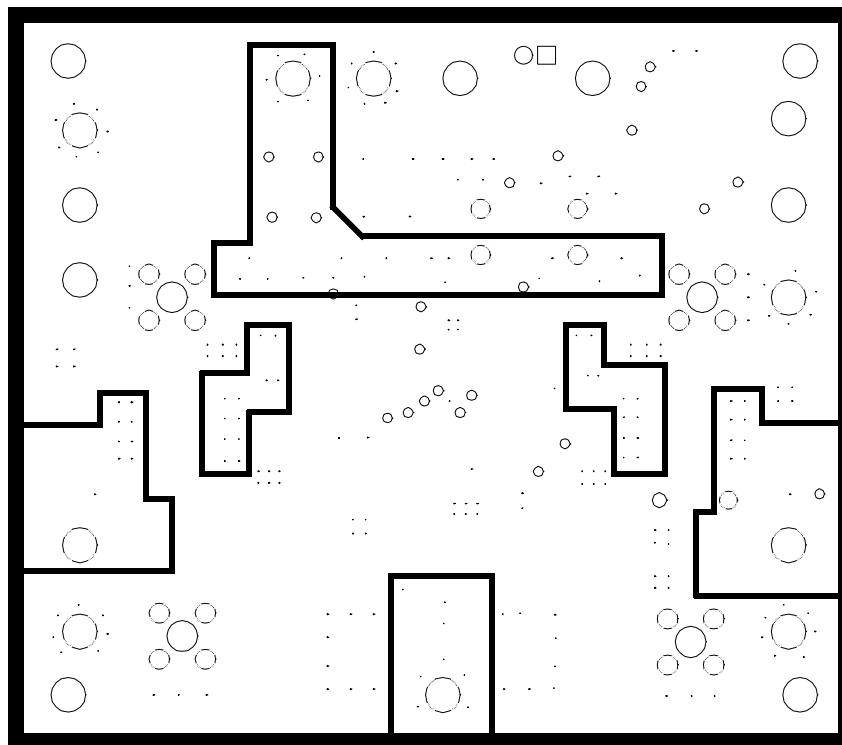


FIGURE 9. TOP



**FIGURE 10. INTERNAL LAYER 1, GND**



**FIGURE 11. INTERNAL LAYER 2, POWER**



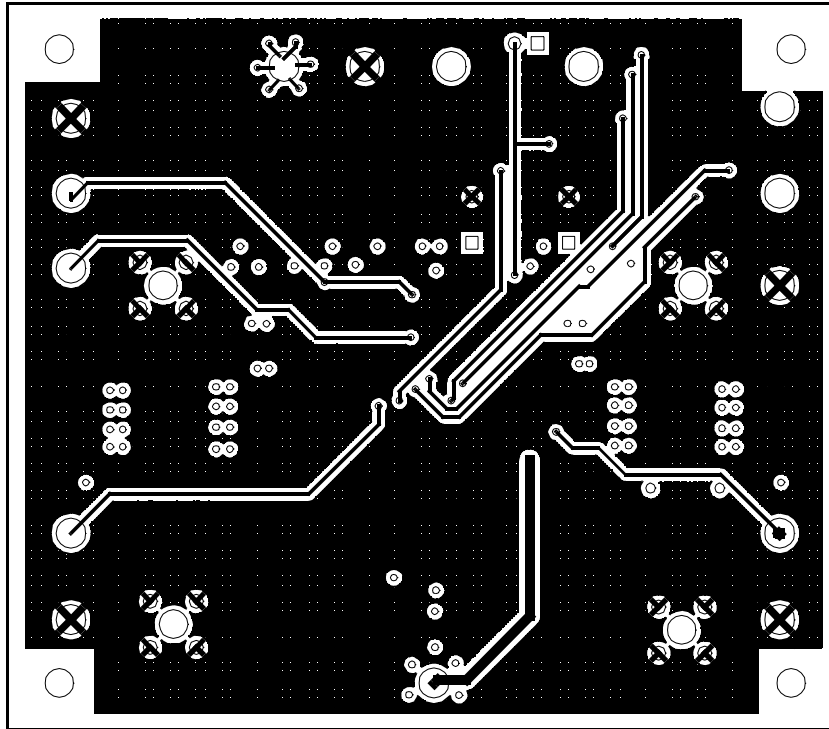


FIGURE 12. BOTTOM, GND

All Intersil U.S. products are manufactured, assembled and tested utilizing ISO9000 quality systems.  
Intersil Corporation's quality certifications can be viewed at [www.intersil.com/design/quality](http://www.intersil.com/design/quality)

*Intersil products are sold by description only. Intersil Corporation reserves the right to make changes in circuit design, software and/or specifications at any time without notice. Accordingly, the reader is cautioned to verify that data sheets are current before placing orders. Information furnished by Intersil is believed to be accurate and reliable. However, no responsibility is assumed by Intersil or its subsidiaries for its use; nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Intersil or its subsidiaries.*

For information regarding Intersil Corporation and its products, see [www.intersil.com](http://www.intersil.com)

### Sales Office Headquarters

#### NORTH AMERICA

Intersil Corporation  
7585 Irvine Center Drive  
Suite 100  
Irvine, CA 92618  
TEL: (949) 341-7000  
FAX: (949) 341-7123

Intersil Corporation  
2401 Palm Bay Rd.  
Palm Bay, FL 32905  
TEL: (321) 724-7000  
FAX: (321) 724-7946

#### EUROPE

Intersil Europe Sarl  
Ave. William Graisse, 3  
1006 Lausanne  
Switzerland  
TEL: +41 21 6140560  
FAX: +41 21 6140579

#### ASIA

Intersil Corporation  
Unit 1804 18/F Guangdong Water Building  
83 Austin Road  
TST, Kowloon Hong Kong  
TEL: +852 2723 6339  
FAX: +852 2730 1433