Freescale Semiconductor
User's Guide

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KIT34700EPEVBE Evaluation Board

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1 Kit Contents / Packing List

- Evaluation Board - KIT34700EPEVBE
- Hardware Document CD, CD34700

2 Important Notice

Freescale provides the enclosed product(s) under the following conditions:

This evaluation kit is intended for use of ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY. It is provided as a sample IC pre-soldered to a printed circuit board to make it easier to access inputs, outputs, and supply terminals. This EVB may be used with any development system or other source of I/O signals by simply connecting it to the host MCU or computer board via off-the-shelf cables. This EVB is not a Reference Design and is not intended to represent a final design recommendation for any particular application. Final device in an application will be heavily dependent on proper printed circuit board layout and heat sinking design as well as attention to supply filtering, transient suppression, and I/O signal quality.

The goods provided may not be complete in terms of required design, marketing, and or manufacturing related protective considerations, including product safety measures typically found in the end product incorporating the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. In order to minimize risks associated with the customers applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards. For any safety concerns, contact Freescale sales and technical support services.

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3 Kit Introduction

The MC34700 is a four output DC to DC regulator for multi-rail applications. The Evaluation Board is designed to provide the user with the ability to configure the part using a single 9V to 18V input supply, a dual supply, or with each regulator supplied individually. The Evaluation Board has three buck regulators that are setup for outputs of 3.3V at 1.5A, 2.5V at 1.25A and 1.25V at 1.25A and an LDO with a 0.9V at 400mA output. Inputs to enable each output channel are provided as well as a Power Good LED indicator.

Channel	Input	Vout	Iout(max)
DC/DC 1	VIN1	3.3 V	1.5 A
DC/DC 2	VIN2	2.5 V	1.25 A
DC/DC 3	VIN3	1.25 V	1.25 A
LDO	VIN_LDO	0.9 V	400 mA

When operating from a single input supply be aware that CH2 and CH3 are run off the output of CH1 and that the LDO is run off the output of CH3. As a result, the output current available from CH1 is not the full 1.5A, but the current remaining after supplying VIN2 and VIN3. Similarly the current available for CH3 is not the full 1.25A.

Channel	Input	Vout	Iout(max)
DC/DC 1	VIN1	3.3 V	1.5 A-((Vout2*Iout2)+(Vout3*(Iout3+Iout LDO))/(Vout1*0.85))
DC/DC 2	VOUT1	2.5 V	1.25 A
DC/DC 3	VOUT1	1.25 V	1.25A-Iout LDO
LDO	VOUT3	0.9 V	400 mA

4 Required Equipment

The following equipment is required to power and make measurements on the MC34700:

a) Power Supply, 9V to 18V adjustable, capable of 2A output current (required).
b) Power Supply, 1.5V to 6V adjustable, capable of 3A output current (optional).
c) Digital Multi-Meter, Agilent 34401A, 6 1/2 digit, or equivalent (required).
d) Oscilloscope, 4 Channel, 500 MHz bandwidth, or equivalent (required).
e) DC Electronic Load, Agilent 6060B, 0V to 6V, capable of 5A, or equivalent (required).
f) DC Current Probe (optional)

5 EVB Setup Configuration Diagram

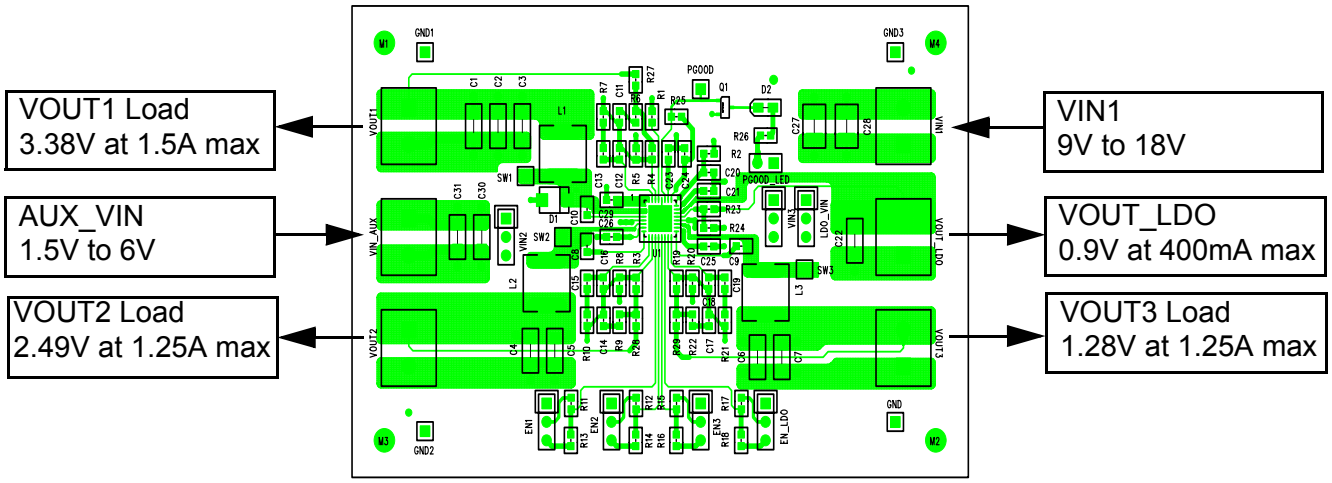


Figure 1. EVB Setup Configuration Diagram

6 Using the Hardware

Use the following steps to verify that the Evaluation Board is operational:

a) Verify jumpers are installed as shown in Jumper Connections Section. Use the default settings.

b) Check polarity and connect a 12V, 2A supply to VIN1 terminal.

c) Check 12V supply current with all the regulators disabled. The supply current should not exceed 15mA.

d) Enable CH1 by moving EN1 jumper to 1-2 position. Verify 3.3V channel is operating by measuring voltage at VOUT1 terminal. VOUT1 is typically 3.38V.

e) Enable CH2 by moving the EN2 jumper to the 1-2 position. Verify the 2.5V channel is operating by measuring the voltage at the VOUT2 terminal. VOUT2 is typically 2.49V.

f) Enable CH3 by moving EN3 jumper to 1-2 position. Verify that the 1.25V channel is operating by measuring the voltage at the VOUT3 terminal. VOUT3 is typically 1.28V.

g) Enable LDO by moving EN_LDO jumper to 1-2 position. Verify 0.9V channel is operating by measuring voltage at VOUT_LDO terminal. VOUT_LDO is typically 0.9V.

h) If all the regulators are up and running, verify that the PGOOD LED (D2) is on.

After board verification, it can be reconfigured and tested per system requirements.

6.1 Jumper Connections

A description of the jumper settings is given in the following table.

Jumper	Position	Default	Description
EN1	1-2 2-3	 X	DC/DC 1 ENABLED DC/DC 1 DISABLED
EN2	1-2 2-3	 X	DC/DC 2 ENABLED DC/DC 2 DISABLED
EN3	1-2 2-3	 X	DC/DC 3 ENABLED DC/DC 3 DISABLED
EN_LDO	1-2 2-3	 X	LDO ENABLED LDO DISABLED
VIN2	1-2 2-3	X	VIN2 CONNECTED TO VOUT1 VIN2 CONNECTED TO VIN_AUX
VIN3	1-2 2-3	X	VIN3 CONNECTED TO VOUT1 VIN3 CONNECTED TO VIN_AUX
LDO_VIN	1-2 2-3	X	LDO_VIN CONNECTED TO VOUT3 LDO_VIN CONNECTED TO VIN_AUX
PGOOD_LED	SHORT OPEN	X	LED is active, running off VOUT1 LED is disconnected

6.2 PGOOD

The evaluation board includes a status LED (D2), that indicates all the regulators are operating and no faults have occurred. The FET, Q1, is required for signal inversion and to drive the LED current. The resistor, R26, limits the LED current.

The jumper (PGOOD_LED) disconnects the status LED for making efficiency and quiescent current measurements. The status LED is connected to the output of CH1 when the jumper is installed.

The test point PGOOD is the open drain output of the PGOOD pin. It is pulled up to VGREG by resistor R25.

6.3 Switch Nodes

The evaluation board includes test points for monitoring the switch nodes of DC/DC 1, 2 and 3. The test points are located close to the output inductors of each channel. The switch nodes can be used to measure switching frequency, duty cycle, phase, and switch times.

6.4 Power Input Voltage

The power input voltage for DC/DC1 (VIN1) is connected to the VIN1 terminal block. The VIN1 input is bypassed with bulk capacitors C27 and C28, and is connected to the IC input pin (VIN) by an RC filter, R2 and C20.

Power inputs for DC/DC 2, and DC/DC 3 (VIN2, and VIN3) can be connected to the AUX_IN terminal or the output of DC/DC 1. By setting the jumpers (VIN2, and VIN3) to position 2-3, each regulator can be powered from the AUX_IN. By setting the jumpers to position 1-2, each regulator can be powered from the output of DC/DC 1.

The power input voltage for the LDO (LDO_VIN) can be connected to the AUX_IN terminal or the output of DC/DC 3. By setting the jumper (LDO_VIN) to position 2-3, the LDO can be powered from the AUX_IN. By setting the jumper to position 1-2, the LDO can be powered from the output of DC/DC 3. The AUX_IN input is bypassed with bulk capacitors C30 and C31.

For single supply operation, set VIN2, VIN3 and LDO_VIN to position 1-2. This connects the input of DC/DC 2 and DC/DC 3 to the output of DC/DC 1 and the LDO input to the output of DC/DC 3.

For dual supply operation, set VIN2, and VIN3 to position 2-3. This connects the input of DC/DC 2 and DC/DC 3 to the AUX_IN terminal block. Set the LDO_VIN to either position depending on the application to connect the LDO input to the output of DC/DC 3 or the AUX_IN terminal.

If each regulator needs to powered from a separate supply, two of the input power jumpers can be removed and an external supply connected directly to header position 2. Select

the regulators with the lowest output power to connect directly to the header pin. The other two regulators are powered from VIN1 and AUX_IN.

6.5 Enables and Cascaded Sequencing

The enable headers are currently configured for a simple enable/disable function. Setting the jumper to position 1-2 connects the enable pin to the VGREG output, enabling the respective regulator. Removing or setting the jumper to position 2-3 connects the enable pin to ground, disabling the respective regulator.

However, the board has provisions to add a resistor divider to each enable pin which allows cascaded sequencing. Resistors R11, R12, R15, and R17 are installed and are 10K Ohm. By installing resistors R13, R14, R16, and R18 a voltage divider is formed at each enable pin. By setting the resistor divider of each enable, the voltage of the enable pin has to reach its' threshold level before the regulator in the sequence is enabled. Note that the jumpers need to be removed and the output of the regulator in the previous sequence position be connected to pin 2 of the enable header. See the data sheet for more details on calculating the divider.

6.6 Leakage Current

DC/DC 2 and DC/DC 3 each have ~400uA of leakage current that can cause the output to float up if there is not enough load current in the application. 1K Ohm resistors are installed at R36 and R37 (located on the bottom side of the PC board) to prevent VOUT2 and VOUT3 from floating when these channels are disabled.

The 1K load can be removed if there is a minimum load of at least 4mA present on VOUT2 and VOUT3.

7 EVB Schematic

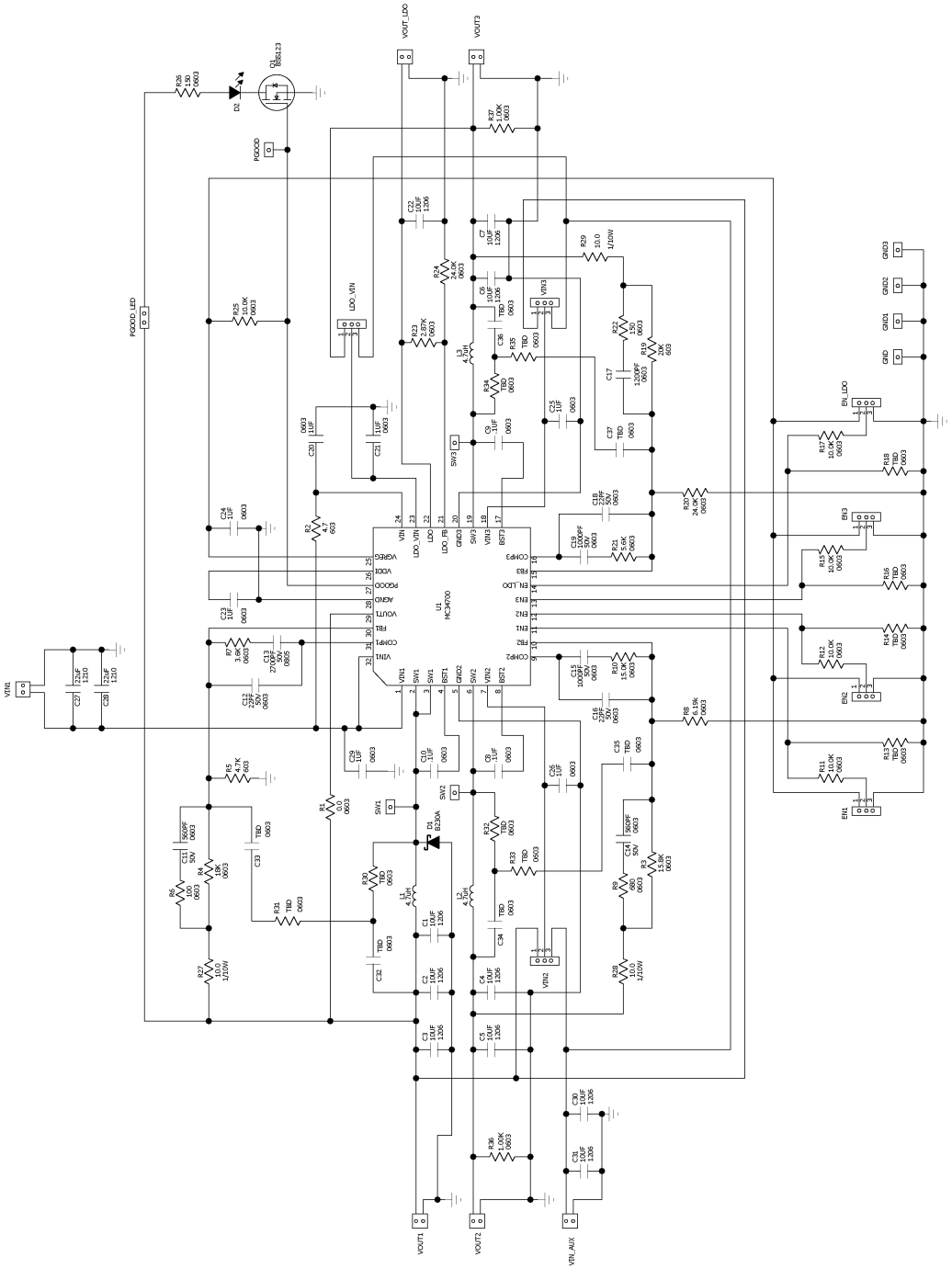


Figure 2. EVB Schematic

8 Board Layout

8.1 Assembly Layer Top

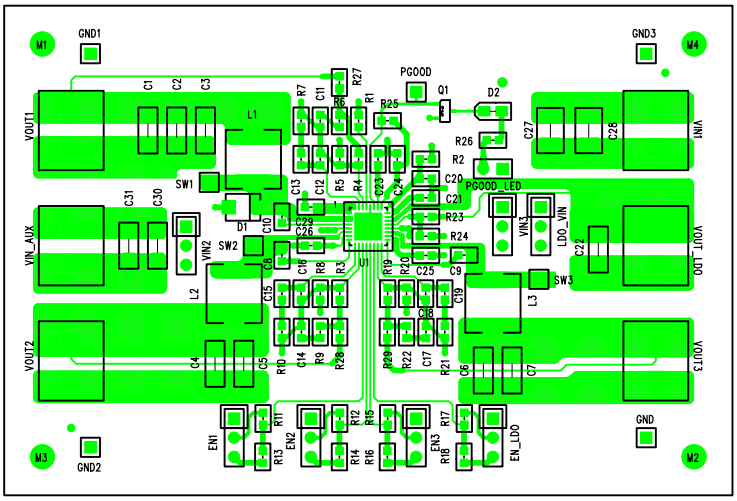


Figure 3. Assembly Layer Top

8.2 Assembly Layer Bottom

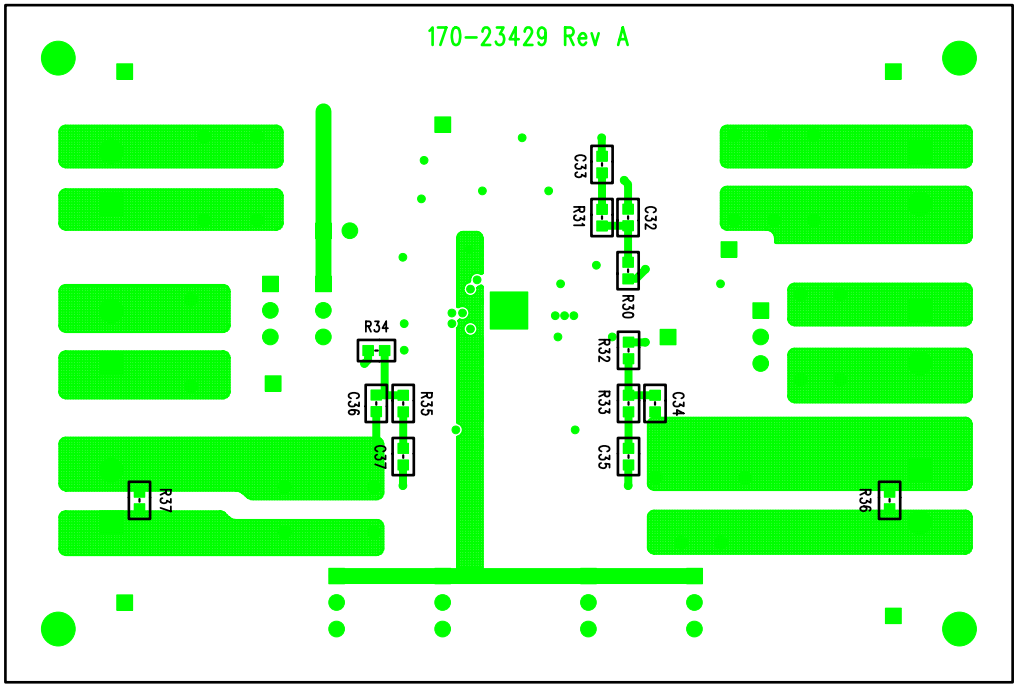


Figure 4. Assembly Layer Bottom

8.3 Top Layer Routing

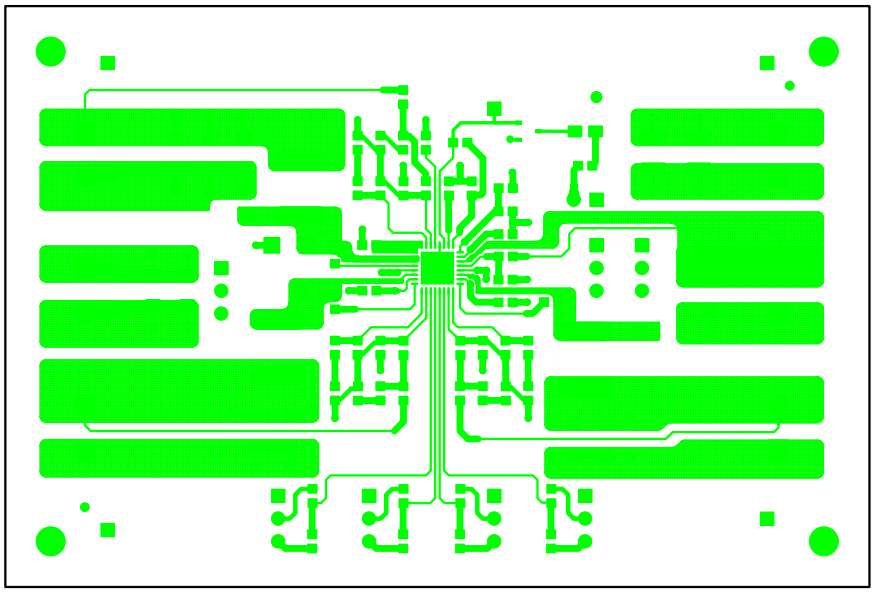


Figure 5. Top Layer Routing

8.4 Inner Layer 2 Routing

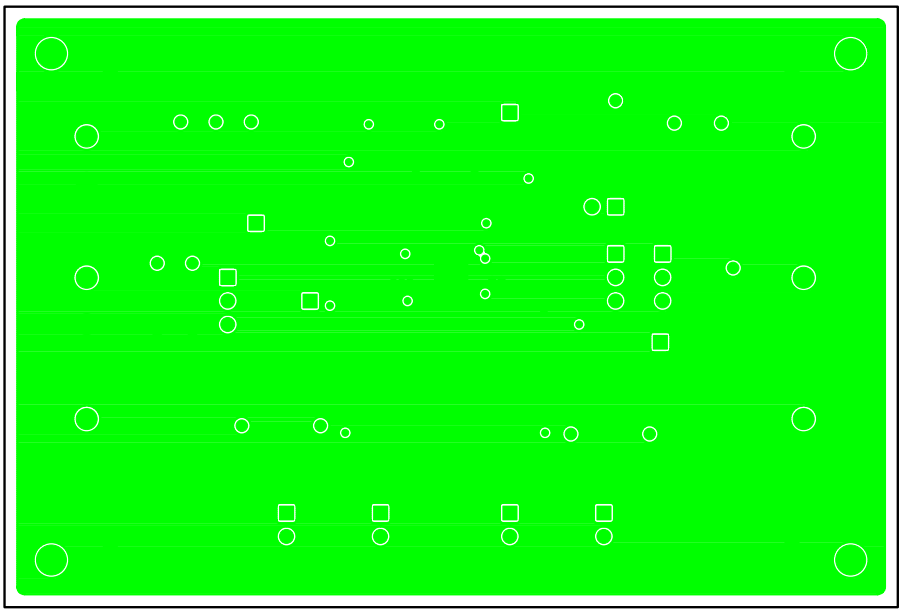


Figure 6. Inner Layer 2 Routing

8.5 Inner Layer 3 Routing

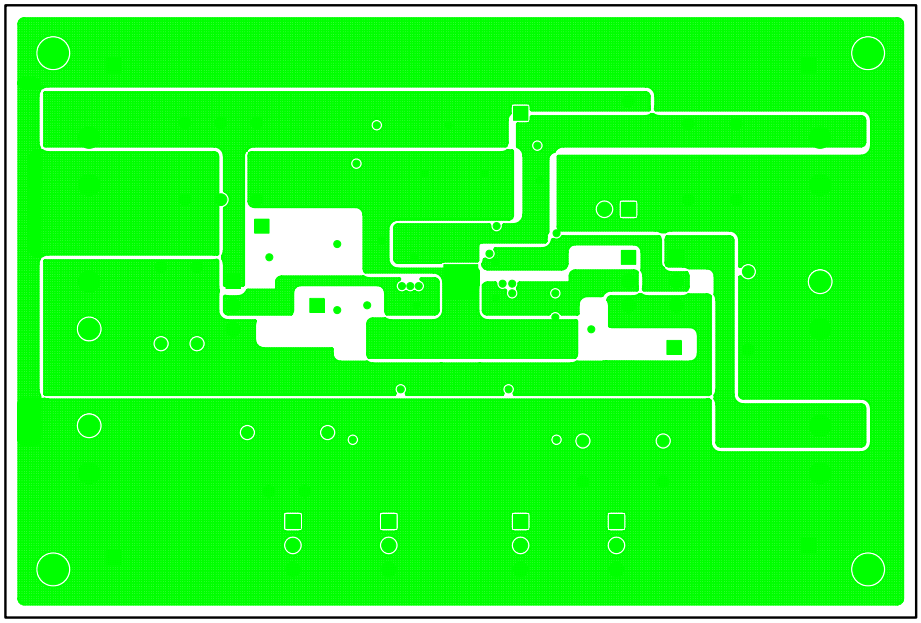


Figure 7. Inner Layer 3 Routing

8.6 Bottom Layer Routing

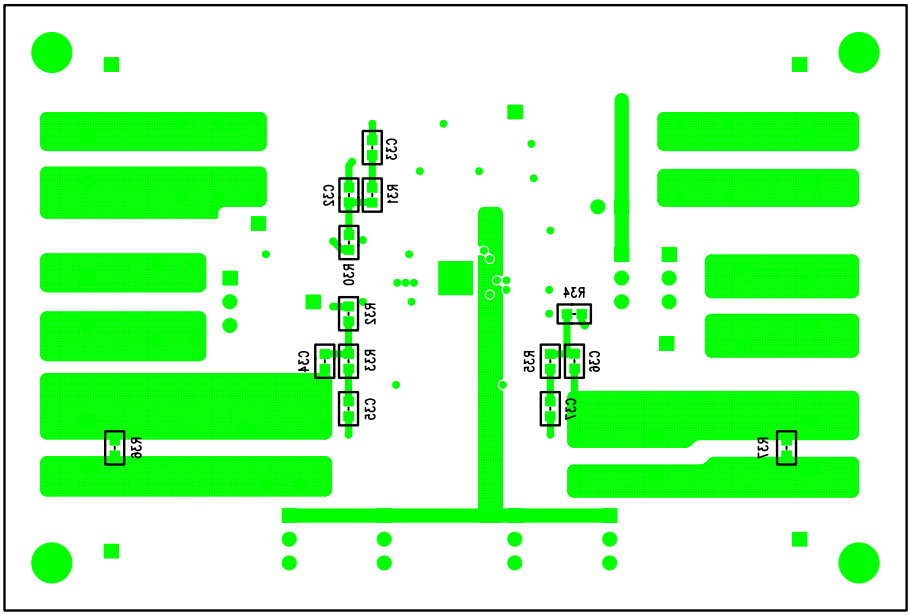


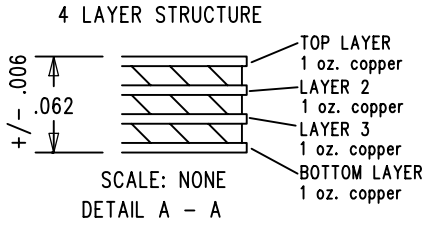
Figure 8. Bottom Layer Routing

8.7 Drill Location

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. BOARD SUBSTRATE FR4 06 Tg IS GREATER THAN OR EQUAL TO 170 DEG C.
2. FINISHED BOARD THICKNESS 0.062" +/− 0.006".
3. PLATING:
   GOLD IMMERSION
4. SOLDER MASK: USE LPI BOTH SIDES
   MEDIUM GREEN, SEMI−GLOSS, HIGHLY TRANSPARENT.
5. BOARD FINISH ENIG.
6. CU WEIGHT 1.0 OZ ALL LAYERS
7. SILK LEGEND WHITE EPOXY INK BOTH SIDES
8. FINISHED DRILL HOLE DIAMETER +/− 0.003" FROM TRUE

SIZE	QTY	SYM	PLATED	TOL
15	32	B	YES	+/−0.003
128	4	F	NO	+/−0.0
37	31	G	YES	+/−0.0
11.81	9	H	YES	+/−0.0
60	12	I	YES	+/−0.0
28	25	J	YES	+/−0.0



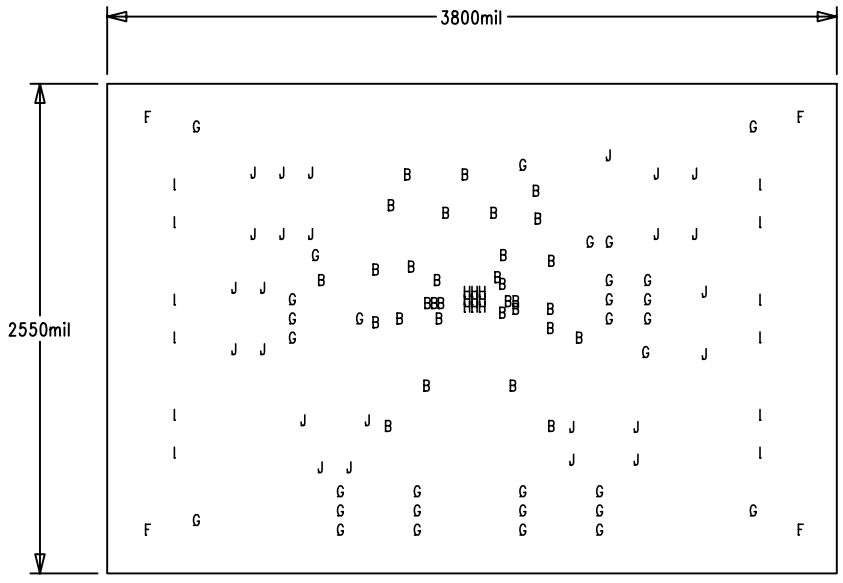


Figure 9. Drill Location

9 Bill of Material

Reference Designation	Value	Qty	Description	Mfr	PN
Freescale Components					
U1	MC34700		Four output, integrated regulator	Freescale	MC34700EP
Capacitors					
C1-C7, C22,C30, C31	10uF	10	CAP, CER, 10uF, 10V, X5R	TDK	C3216X5R1A106M
C8,C9, C10	0.1uF	3	CAP, CER, 0.1uF, 25V, X7R	TDK	C1608X7R1E104K
C11, C14	560pF	2	CAP, CER, 560pF, 50V, COG	Panasonic	ECJ-1VC1H561J
C12,C16, C18	22pF	3	CAP, CER, 22pF, 50V, COG	Panasonic	ECJ-1VC1H220J
C13	2.7nF	1	CAP, CER, 2700pF, 50V, X7R	Panasonic	ECJ-1VB1H272K
C15,C19	1000pF	2	CAP, CER, 1000pF, 50V, X7R	Panasonic	ECJ-1VB1H102K
C17	1.2nF	1	CAP, CER, 1200pF, 50V, X7R	Murata	GRM188R71H122KA01D
C20,C21, C23-C26, C29	1.0uF	7	CAP, CER, 1.0uF, 25V, X5R	Murata	GRM188R61E105KA12D
C27,C28	22uF	2	CAP, CER, 22uF, 25V, X5R	Murata	GRM32ER61E226KE15L
C32-C37			Not Populated		
Resistors					
R1	0 Ohm	1	RES, 0.0 Ohm, 1/10W, 5%	Vishay/Dale	CRCW06030000Z0EA
R2	4.7 Ohm	1	RES, 4.7 Ohm, 1/10W, 1%	Vishay/Dale	CRCW06034R70FNEA
R3	15.8K	1	RES, 15.8K Ohm, 1/10W, 1%	Yageo	RC0603FR-0715K8L
R4	18.0K	1	RES, 18.0K Ohm, 1/10W, 1%	Yageo	RC0603FR-0718KL
R5	4.7K	1	RES, 4.70K Ohm, 1/10W, 1%	Yageo	RC0603FR-074K7L
R6	200 Ohm	1	RES, 200 Ohm, 1/10W, 1%	Yageo	RC0603FR-07200RL
R7	3.60K	1	RES, 3.60K Ohm, 1/10W, 1%	Yageo	RC0603FR-073K6L
R8	6.19K	1	RES, 6.19K Ohm, 1/10W, 1%	Yageo	RC0603FR-076K19L
R9	680 Ohm	1	RES, 680 Ohm, 1/10W, 1%	Yageo	RC0603FR-07680RL
R10	15.0K	1	RES, 680 Ohm, 1/10W, 1%	Yageo	RC0603FR-0715KL
R11,R12, R15,R17, R24,R25	10.0K	6	RES, 680 Ohm, 1/10W, 1%	Vishay/Dale	CRCW060310K0FKEA
R13,R14, R16,R18			Not Populated		
R19	20.0K	1	RES, 20.0K Ohm, 1/10W, 1%	Yageo	RC0603FR-0720KL
R20	24.0K	1	RES, 24.0K Ohm, 1/10W, 1%	Yageo	RC0603FR-0724KL
R21	5.60K	1	RES, 5.60K Ohm, 1/10W, 1%	Yageo	RC0603FR-075K6L
R22,R26	150 Ohm	2	RES, 150 Ohm, 1/10W, 1%	Vishay/Dale	CRCW0603150RFKEA
R23	2.87K	1	RES, 2.87K Ohm, 1/10W, 1%	Yageo	RC0603FR-072K87L
R27-R29	10 Ohm	3	RES, 150 Ohm, 1/10W, 1%	Vishay/Dale	CRCW060310R0FKEA
R30-R35			Not Populated		
R36, R37	1.00K	2	RES, 1.00K Ohm, 1/10W, 1%	Yageo	RC0603FR-071K00L

Reference Designation	Value	Qty	Description	Mfr	PN
Connectors					
EN1-EN3, EN_LDO, VIN_LDO, VIN2,VIN3		7	HEADER, 3 x 1, single row, 2.54mm, gold flash, head = 0.230”, tail = 0.120”	Sullins	PBC36SAAN
GND, PGOOD,SW1-SW3, GND1-GND3		8	HEADER, 1 x 1, straight pin, 2.54mm, gold flash, head = 0.230”, tail = 0.120”	Sullins	PBC36SAAN
PGOOD_LED		1	HEADER, 1 x 2, single row, 2.54mm, gold flash, head = 0.230”, tail = 0.120”	Sullins	PBC36SAAN
VIN1, VIN_AUX VOUT1 - VOUT3, VOUT_LDO		6	TERMINAL BLOCK, 300V, 16A, 28-12AWG	Phoenix	MKSDN 1.5/2
EN1-EN3, EN_LDO, VIN_LDO, VIN2,VIN3 PGOOD_LED		8	Shorting Jumper, gold flash	Sullins	SPC02SYAN
Misc.					
L1, L2,L3	4.7uH	3	INDUCTOR, 4.7uH, 2.9A, 35mOhm, 7.3 x 7.3 x 3.2mm	TDK Wurth	RLF7030T-4R7M3R4 744 778 9004
D1	B230	1	DIODE, Schottky, 30V, 2A, SMA	Diodes, Inc	B230A-13-F
D2	LED	1	LED, Red, Vf = 1.8V, 30mA, 100mW	Lumex	SML-LXT0805SRW-TR
Q1	BSS123	1	N-MOSFET, BSS123, 100V, 170mA	Fairchild	BSS123

Freescale does not assume liability, endorse, or warrant components from external manufacturers that are referenced in circuit drawings or tables. While Freescale offers component recommendations in this configuration, it is the customer’s responsibility to validate their application

10 References

Following are URLs where you can obtain information on other Freescale products and application solutions:

Description	URL
Data Sheet - MC34700	www.freescale.com/files/analog/doc/data_sheet/MC34700.pdf
Fact Sheet - MC34700FS	
Application Note - Low Power Management Unit with MC34700 AN3592	www.freescale.com/files/microcontrollers/doc/app_note/AN3592.pdf
Application Note - Quad Flat Pack No-Lead (QFN) AN1902	www.freescale.com/files/analog/doc/app_note/AN1902.pd
Freescale's Web Site	www.freescale.com
Freescale's Analog Web Site	www.freescale.com/analog
Freescale's Power Management Web Site	www.freescale.com/powermanagement

11 Revision History

REVISION	DATE	DESCRIPTION OF CHANGES
1.0	7/2008	• Initial Release

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