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Powering the i.MX27 with the 5 Channel MC34704B IC

1 Overview

This document presents an analysis of the possibility to use the 5 Channel MC34704B power management IC to supply a system based on i.MX27. The focus was done on i.MX27 itself, considering its needs in terms of voltage, current and power up sequence. The needs to supply the DDR and Flash memories were also taken into account.

2 Scope

With the info presented here, the i.MX27 can be supplied so it will work on a basic application on which low power modes can not be accessed due to the absence of power gating system on the MC34704B. To be able to use low power modes, extra circuitry must be added to the system.

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3 i.MX27 Power Requirements

i.MX27 Power Signal	Symbol	Min.	Typ	Max	Units
Core Voltage Supply (@266MHz)	QVDD	1.2	1.3	1.52	V
Core Voltage Supply (@400MHz)	QVDD	1.38	1.45	1.52	V
RTC, SCC, Separate Supply Voltage	RTCVDD	1.2	-	1.52	V
Analog Supply Voltage: FPMVDD, UPLLVDD, MPLLVDD	VDD	1.35	1.4	1.6	V
OSC32VDD	VOSC32	1.1	-	1.6	V
I/O Supply Voltage, Fast (7, 11, 12, 14, 15)	NVDD_FAST	1.75	-	2.8	V
I/O Supply Voltage, Slow (5, 6, 8, 9, 10, 13, AVDD)	NVDD_SLOW	1.75	-	3.05	V
OSC26VDD	VOSC26	2.68	-	2.875	V
I/O Supply Voltage, DDR (1, 2, 3, 4)	NVDD_DDR	1.75	-	1.9	V
Fuse box read Supply Voltage	FUSE_VDD	1.7	1.875	1.95	V
Fuse box Program Supply Voltage	FUSE_VDD	3	3.15	3.3	V

3.1 i.MX27 Power Up Sequence

The i.MX27/MX27L processor consists of three major sets for power supply voltage named QVDD (core logic supply), FUSEVDD (analog supply for FUSEBOX), and NVDDVDDA (IO supply). The External Voltage Regulators and power-on devices must provide the applications processor with a specific sequence of power and resets to ensure proper operation.

It is important that the applications processor power supplies be powered-up in a certain order to avoid unintentional fuse blown. QVDD should be powered up before FUSEVDD.

If the core operating frequency is set to 266MHZ and VDDQ supply group is required to be 1.3V, then, an extra voltage rail is needed to provide the Analog supply Voltage. Otherwise, if Core supply voltage can be set higher or operating frequency is 400MHz core supply and Analog supply can be sourced from a single power supply at a typical value of 1.45V.

Noticed that since the maximum operating voltage for the Core voltage group is 1.52V, caution must be taken in order to have a very tight regulation and avoid overstressing or blowing the microprocessor terminals.

4 MC34704B 5 Ch. DC/DC Power Management IC

The MC34704B is a multi-channel Power Management IC (PMIC) used to address power management needs for various multimedia application microprocessors. Its ability to provide 5 independent output voltages with a single input power supply (2.7 and 5.5V) together with its high efficiency, make it ideal for portable devices powered up by Li-Ion/polymer batteries or for USB powered devices as well.

The MC34704B is housed in a 7x7mm, Pb-free, QFN56 and is capable of operating at a switching frequency of up to 2MHz. This makes it possible to reduce external component size and to implement full space efficient power management solutions.

Features

- 5 DC/DC (MC34704B) switching regulators with up to ±2% output voltage accuracy
- Dynamic voltage scaling on all regulators
- Selectable voltage mode control or current mode control on REG8
- I2C programmability
- Output under-voltage and over-voltage detection for each regulator
- Over-current limit detection and short-circuit protection for each regulator
- Thermal limit detection for each regulator
- Integrated compensation for REG3 and REG8
- 5μA maximum shutdown current (All regulators are off, 5.5V VIN)
- True cutoff on all of the boost and buck-boost regulators
- Pb-free packaging designated by suffix code EP

4.1 MC34704B Capabilities

MC34704B Capabilities					
Regulator	**Output Voltage (V)**			**Output Current (mA)**	
	Min.	**Typ**	**Max**	**Typ**	**Max**
Reg2	0.6	2.8/3.3	3.6	200	500
Reg3	0.6	1.2/1.5/1.8	1.8	150	550
Reg4	0.6	1.8/2.5	3.6	100	300
Reg5	0.6	3.3	3.6	150	550
Reg8	5	15	15	15	30

4.2 Interface Diagram

The diagram below shows how the communication pins and power sources must be connected to the i.MX27, and the output voltage for which each one must be configured.

It is a good practice to place ferrite beads on the REG2 voltage supply in order to avoid noise caused for supplying three different voltage domains in the i.MX27:

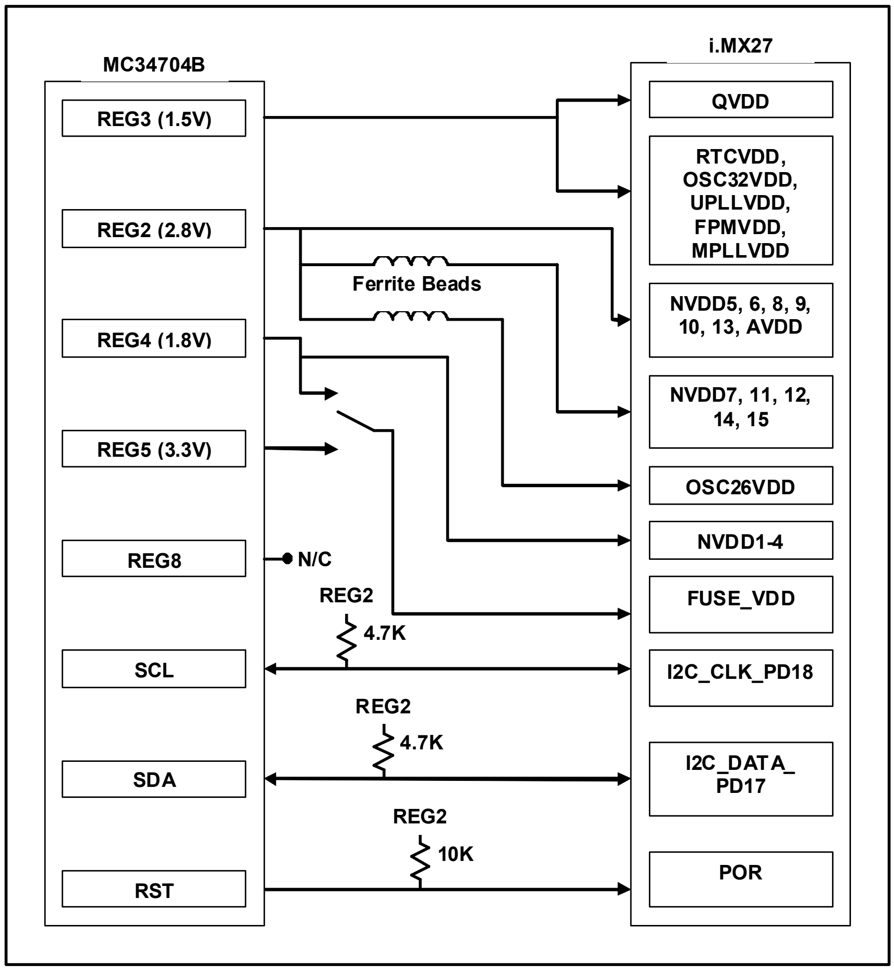

Figure 1. Interface Diagram

As can be seen, REG8 of MC34704B is available to supply other peripherals or external circuitry that may require 5 to 15V at 30mA.

RST signal on the MC34704B goes low as soon as regulators 2, 3 and 4 have reached a stable state at their final value. This indicates the i.MX27 that all the voltages are ready for it to start operating. When this signal goes low, the i.MX27 restarts all the modules and peripherals to a known state so the system can start its operation.

I2C communication is established through pins SCL and SDA of the MC34704B, which have to be connected to I2C_CLK_PD18 and I2C_DATA_PD17 of the i.MX27 respectively.

4.3 Power Sequencing

The MC34704B turns on its regulators following this sequence:

- REG3
- REG2
- REG4

Each of the regulators has a soft start time given by a voltage applied to the SS pin. For this application, a 8ms soft start has to be used, for which a resistor divider must be placed from VDDI to ground, as shown in the following picture.

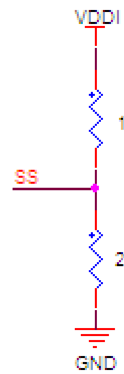

Figure 2. Resistor Divider

This is how the startup sequence looks like on the MC34704B:

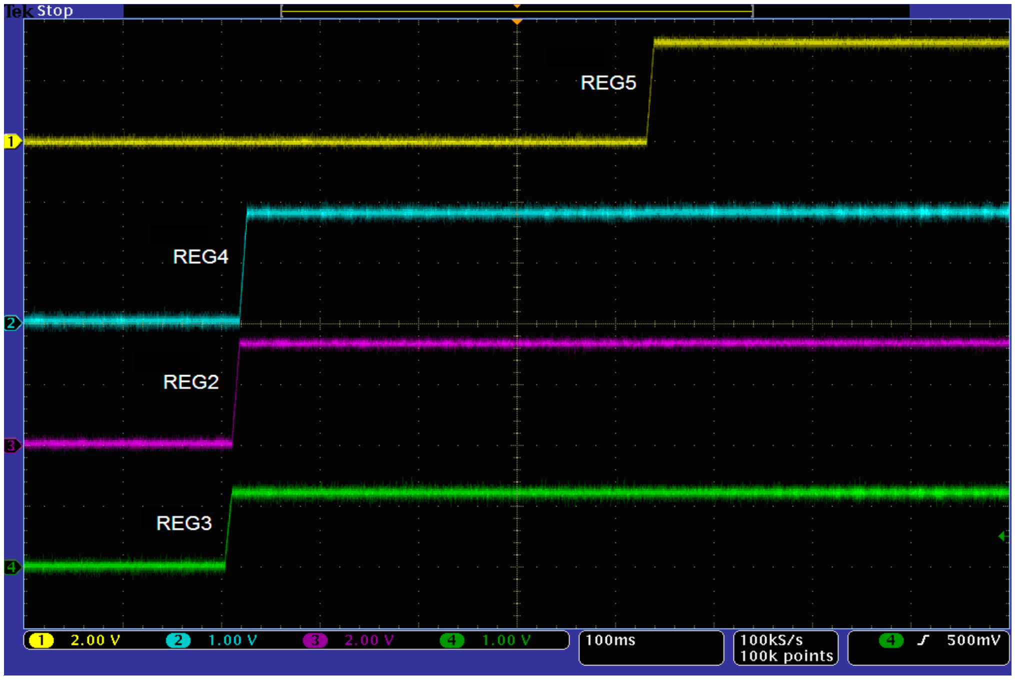

Figure 3. Sequencing 1

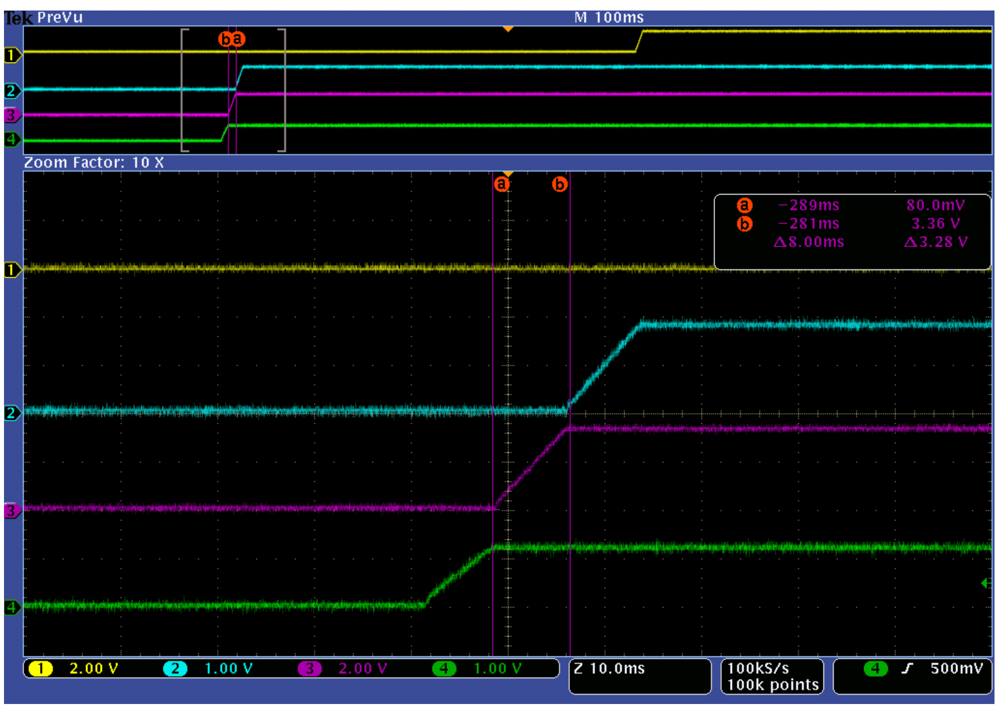

Figure 4. Sequencing 2

The following flow diagram shows how the power pins of the i.MX27 will be turned on according to the power on sequence of the MC34704B.

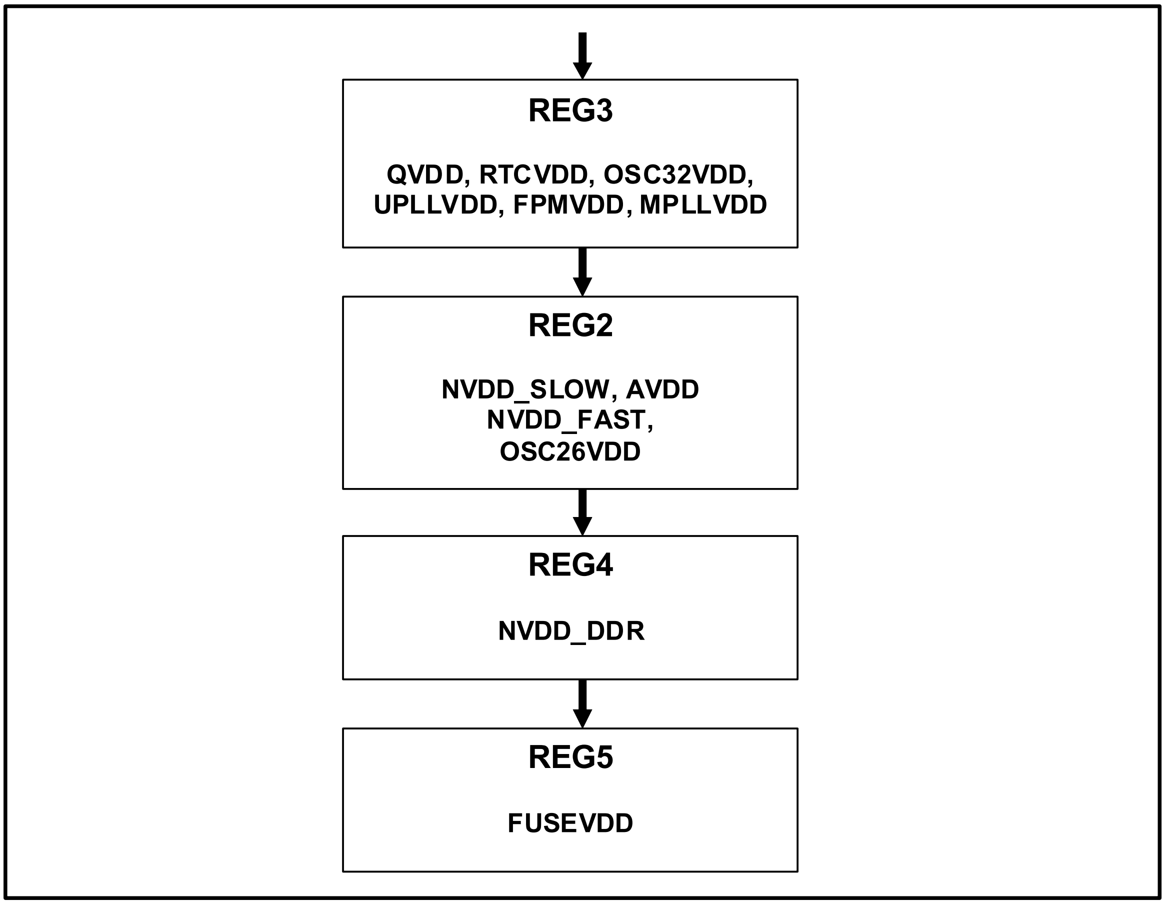

Figure 5. Flow Diagram

5 Software Considerations

The MC34704B is programmed through a plain I2C protocol, the I.MX processor should include a firmware driver to translate the controlling instructions into I2C commands to allow register writing and flag reading for communication acknowledge. Such driver structure is not defined in this document, instead, it will be discussed only the software portion concerning the MC34704B As well as the I2C commands needed to interact with the MC34704B.

The Power on process is very straight forward:

- If there is a battery insertion, REG3, 2 and 4 will turn on in that order enabling I2C communication protocol as well as i.MX processor power on sequence; in such case, the MC34704B will set the COLDF flag to acknowledge that power on was a result of battery insertion. During the power on process, the MPU should acknowledge that power up was a result of a battery insertion and then send an ALLOFF I2C command to disable the power supply and shut down until a desired hardware Power on is present.
- If the ON/OFF terminal sees a falling edge, then the MC34704B start a power on cycle ramping up regulator 3, 2 and 4. In this case, the COLDF bit is not set high, thus, when the i.MX processor read this register it acknowledge it is an actual power up and start a full power on sequence. By this time, PMIC is providing 1.45V, 1.8V and 2.7V, and the processor can provide following configuration commands:
  - REG2, REG3, REG4 OV/UV response
  - REG5 OV/UV response
  - REG5 Soft start timing (if desired)
- At this point the processor can send a REG5 ON/OFF instruction via I2C when the 3.15V rail is required. From now on, all voltage rails can be dynamically scaled up or down using the DVS register and processor can send a power off command when required.

6 Component Selection

6.1 Inductors

VG serves as internal supply for all gate drivers within the MC34704B, L1 dimensions depends directly on the inductance value and the saturation current ISAT, chose and inductor with inductance value between 2.2 to 4.7uH, and ISAT around 150mA.

To select Inductors L2 - L5, choose inductance values between 3.0 to 4.7uH, with an ISAT of approximately twice the maximum current to be demanded from each regulator. As approximate values, the regulators will be supplying:

Regulator	Current (mA)
Reg2	30
Reg3	400
Reg4	60
Reg5	60

Note: make sure to use power inductor and not choke inductors for these components to assure correct performance of the MC34704B.

6.2 Capacitors and Resistors

Choose capacitors with at least twice the voltage rating as the maximum voltage that the capacitor will be exposed to. for the output inductors, use capacitance values from 10 to 22uF.

Resistors are very straight forward to choose, the only important thing while calculating the output voltage of each regulator, is to take the resistor accuracy into consideration specially on those voltage rails where the output voltage is close to the maximum voltage rating of the I.MX terminal; a miscalculation of the resistor accuracy may cause the output voltage to go slightly above the maximum allowed overstressing or damaging the processor terminal in the application. Use 1% or smaller tolerance resistors to have a good control of output voltage values.

Note: for more details on external component calculation, please refer to the MC34704B data sheet that can be found at www.freecale.com.

7 Schematic

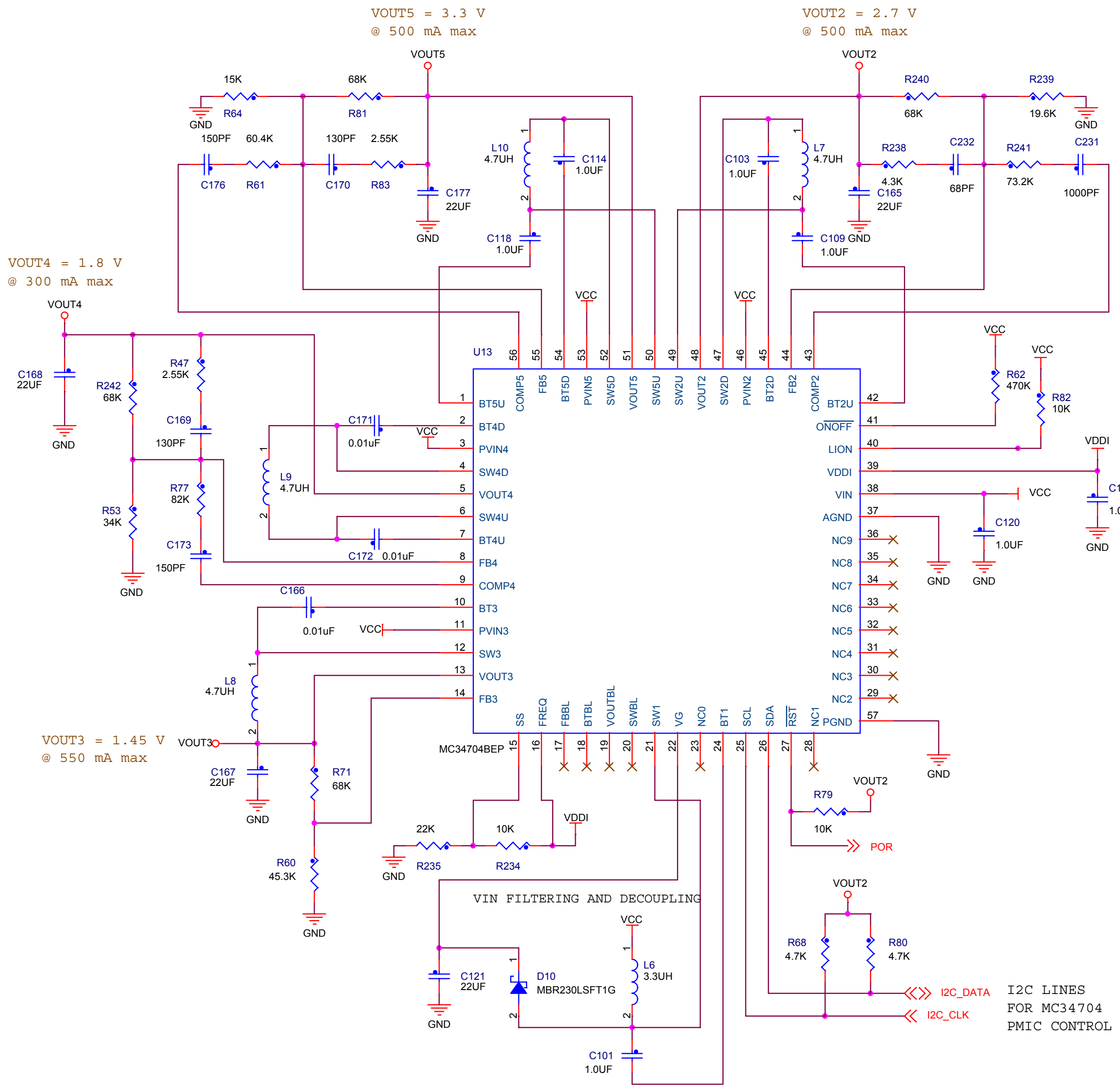

Figure 6. MC34704B Schematic

8 Layout Example

The following is an example of a layout for the MC34704B proposed to work with the I.MX27 Microprocessor, total area is not 100% optimized in order to show the output voltage rails and the communication lines on the power management solution. Freescale proposed layout is designed in 4 layers, using top and bottom layer for routing and component placing and Inner1 and Inner2 layers for Power and Ground respectively. In this document only Top and Bottom layers are presented, since the inner layers are full planes as described above.

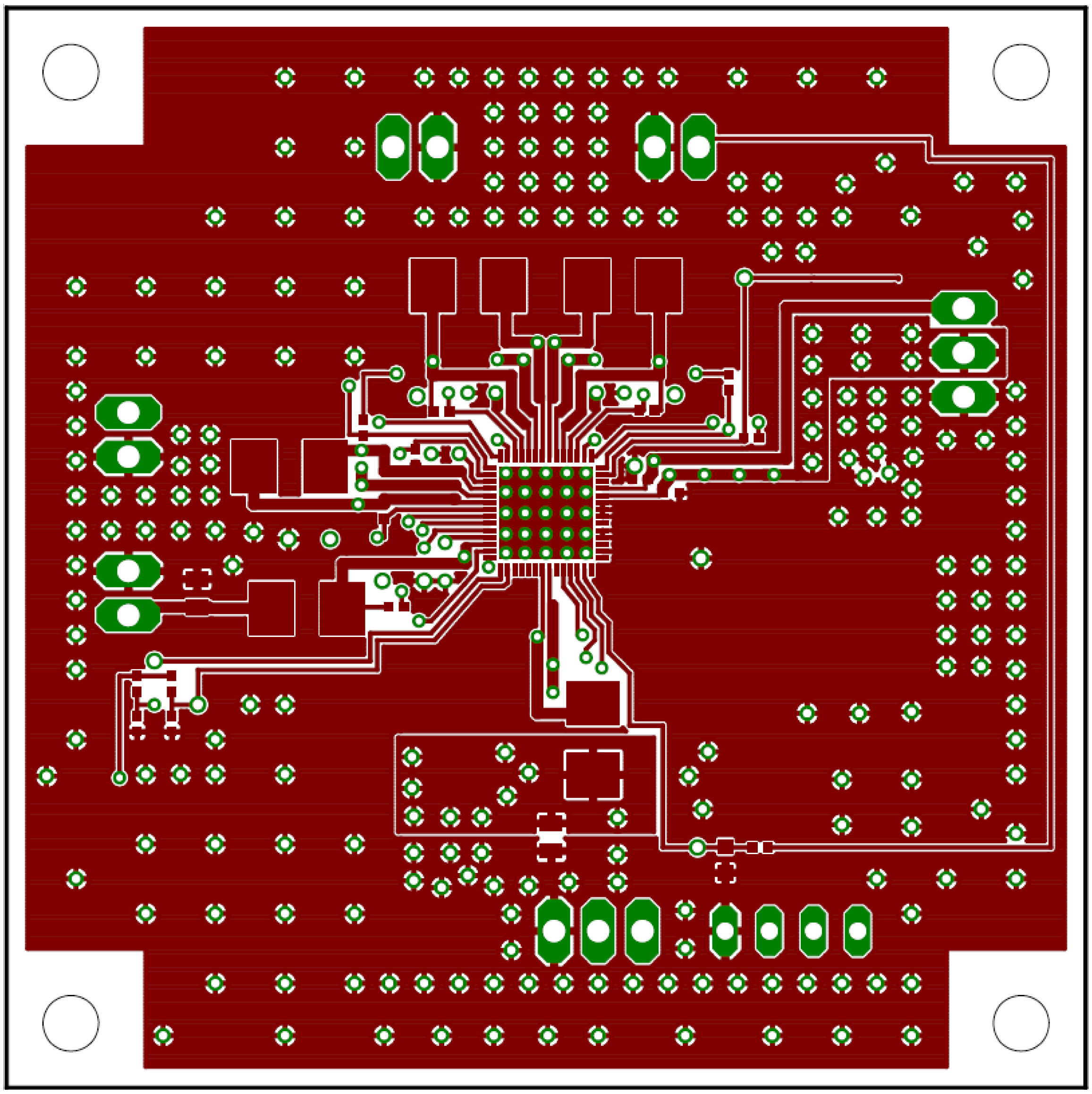

Figure 7. Top Copper

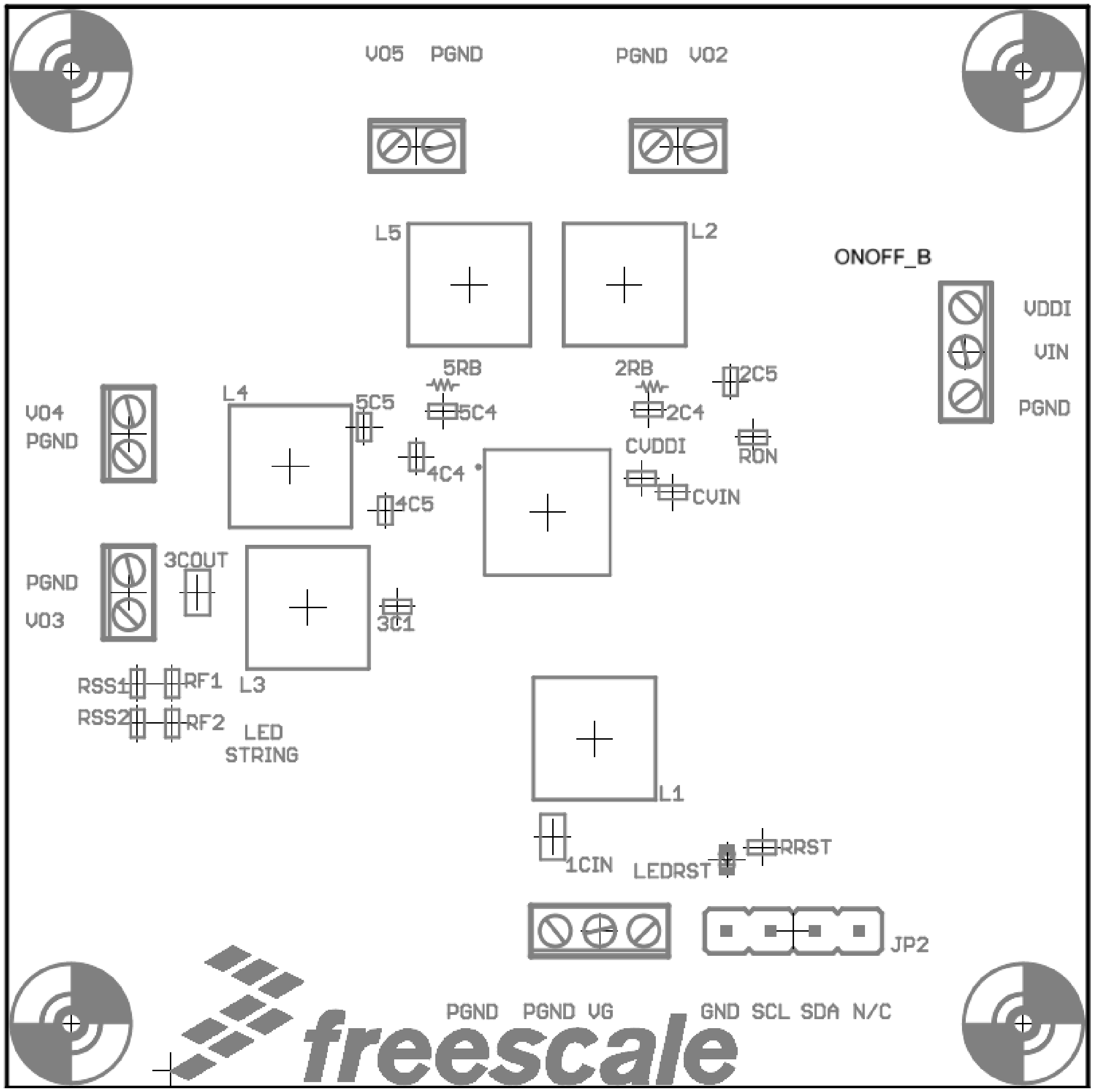

Figure 8. Top Silk Screen

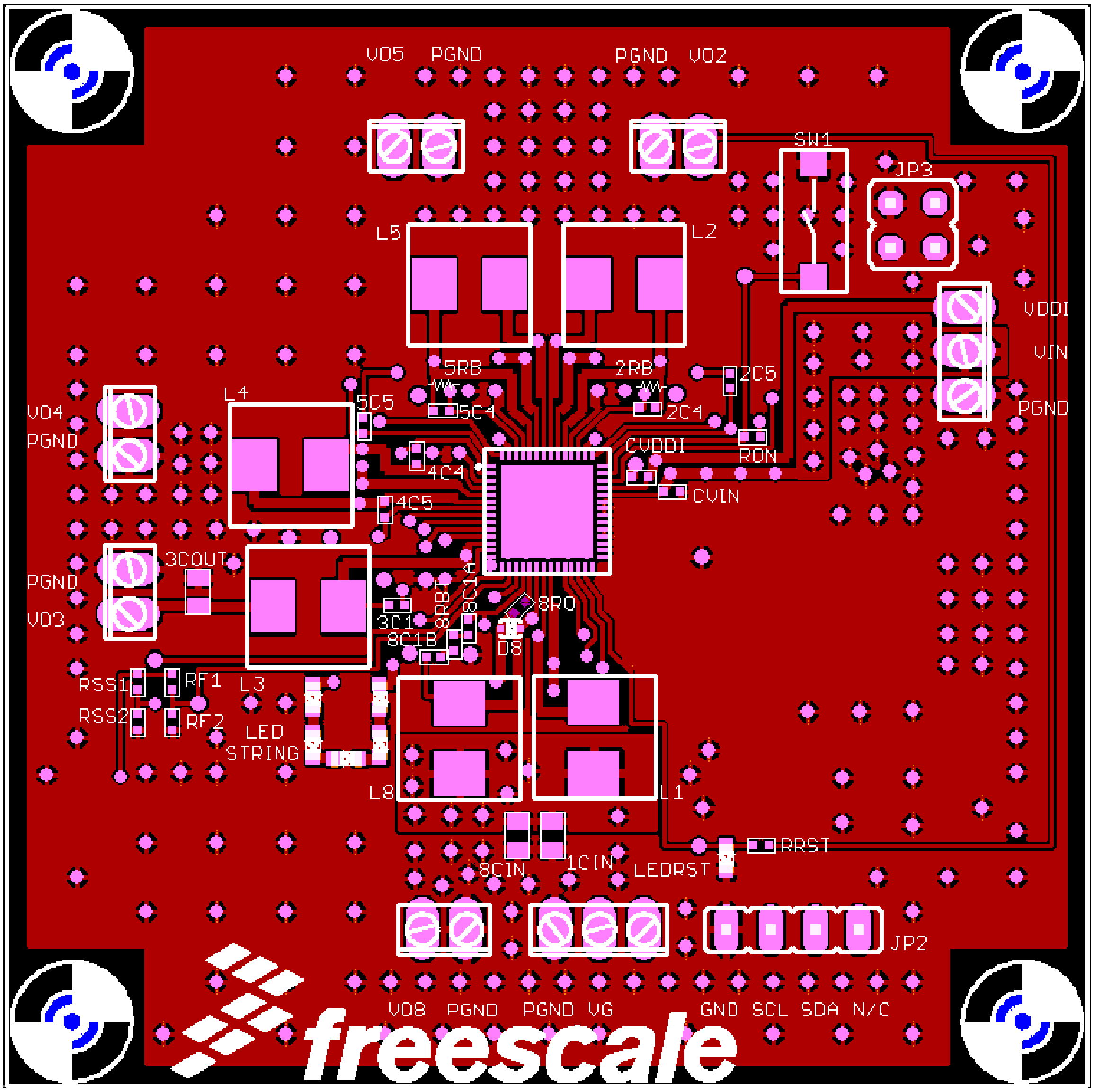

Figure 9. Top Copper and Silk Screen

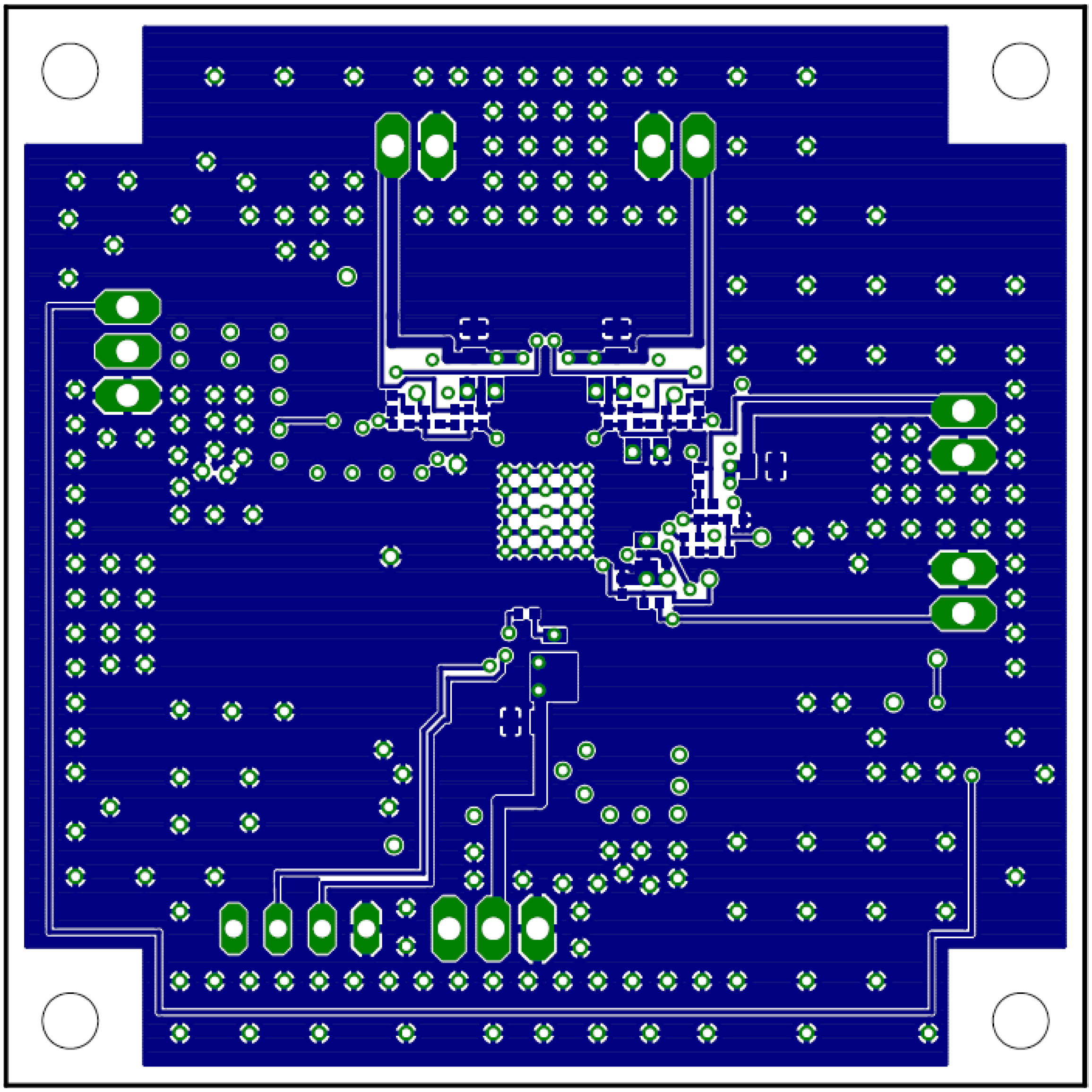

Figure 10. Bottom Copper

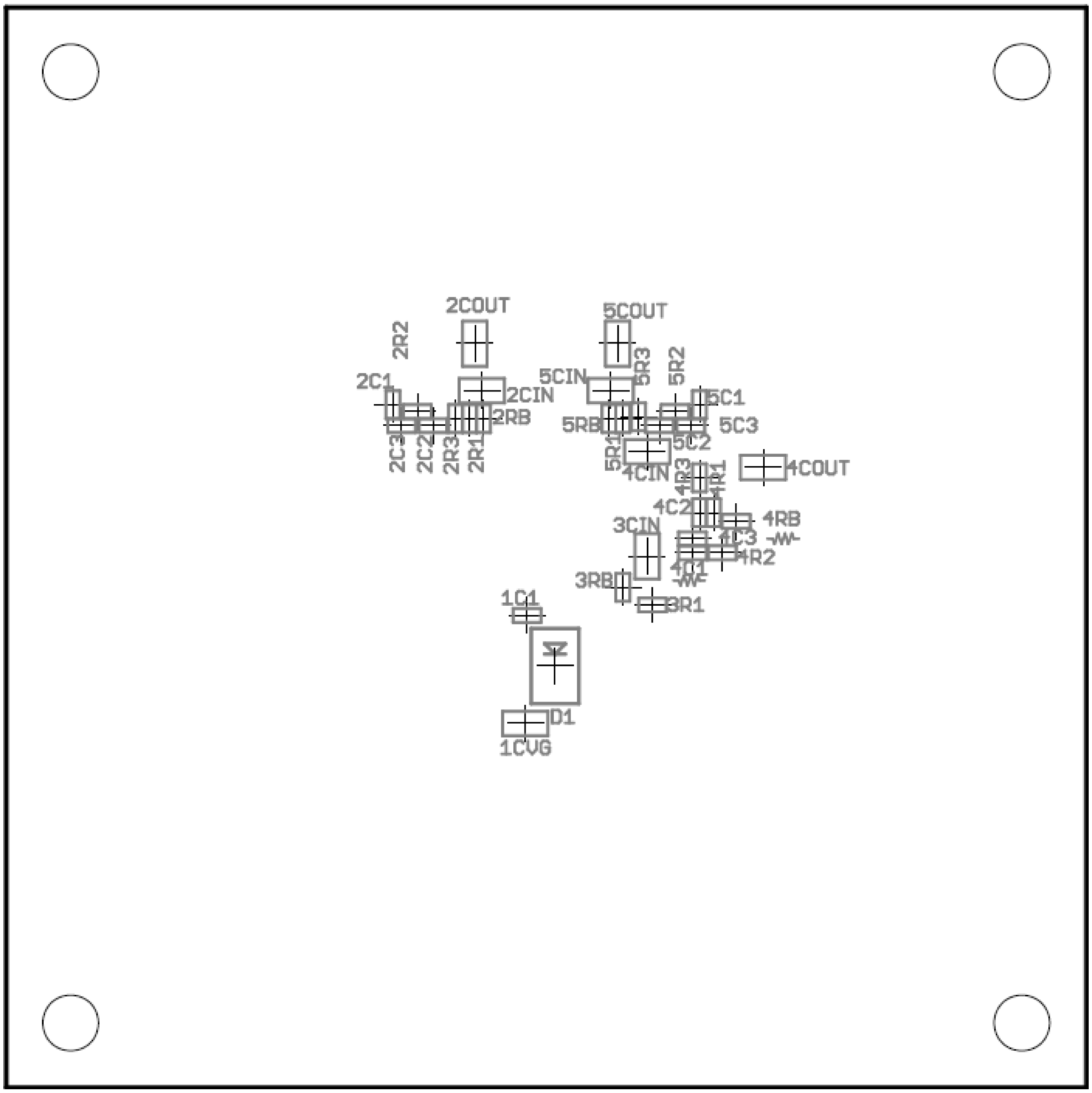

Figure 11. Bottom Silk Screen.

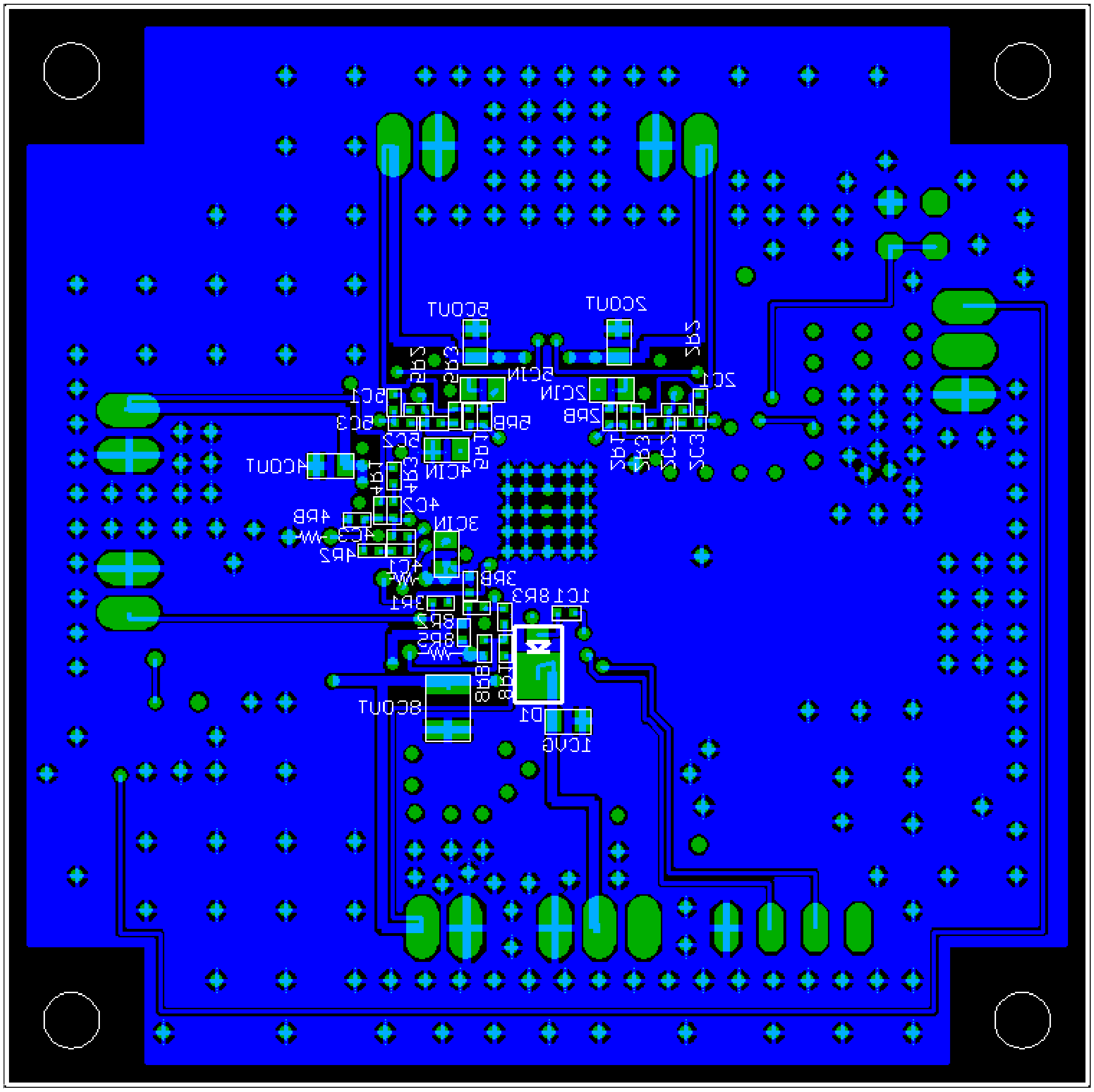

Figure 12. Bottom Copper and Silk Screen.

9 Layout Considerations

- Create a Ground plane layer and tie it to ground signals with vias
- Place Test vias as close as possible to the IC to ensure a good measurement value
- PVIN, VIN, VOUT signals have to be tracked with a widely and straight copper area
- Never trace the Feedback signal in parallel to the SW signal
- Ensure the SW Inductor is placed as close as possible to its pads
- SW track has to be as thin and short as possible
- Make sure the I/O connectors are capable to manage the Load current

10 Revision History

Revision	Date	Description Of Changes
1.0	12/2008	• Initial Release

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