LM3150 Evaluation Boards

National Semiconductor
Application Note 1900
Maurice Eaglin
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Introduction

The LM3150 evaluation boards are designed to provide the design engineer with a fully functional power converter based on Constant On-Time with Emulated Ripple mode control to evaluate the LM3150 and the entire LM315x family of parts. The evaluation board is pre-configured to use the LM3150 with the output voltage pre-set to 3.3V, with a typical max load current of 10A. There are three different boards that are configured for 250 kHz, 500 kHz, and 750 kHz respectively. The printed circuit board consists of 4 layers of FR4 material with the top and bottom layers using 2 ounce copper and the inner layers using 1 ounce copper. The board size is 2.9" X 2.9".

The evaluation board allows for a variety of configurations, and this multifunctional capability is used to also accept the fixed output versions of the LM3150 such as the LM3151-3.3, LM3152-3.3, and the LM3153-3.3.

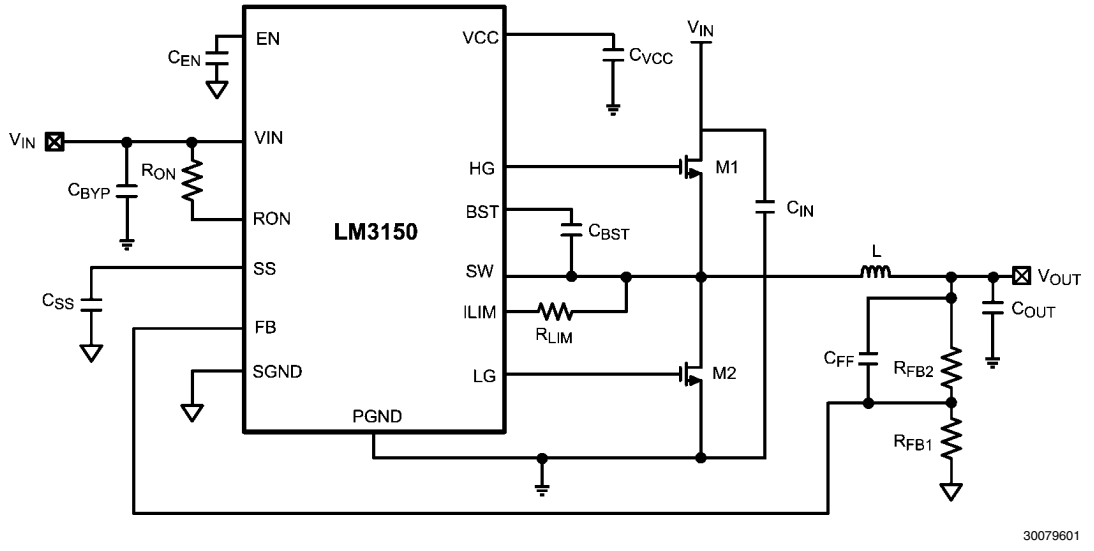
The performance of the synchronous rectifier buck evaluation boards are as follows:

Switching Frequency: 250 kHz
- Input Range: 6V to 42V
- Output Voltage: 3.3V
- Output Current: 0 to 10A

Switching Frequency: 500 kHz
- Input Range: 6V to 24V
- Output Voltage: 3.3V
- Output Current: 0 to 10A

Switching Frequency: 750 kHz
- Input Range: 8V to 17V
- Output Voltage: 3.3V
- Output Current: 0 to 10A

Evaluation Board Schematic



Powering and Loading Considerations

Read this entire page prior to attempting to power the evaluation board.

QUICK SETUP PROCEDURE

Step 1: Set the input power supply current limit to 10A. Turn off the input power supply. Connect the power supply to the V_{IN} terminals.

Step 2: Connect the load, with up to 10A capability, to the V_O terminals. Positive connection to V_O and the negative connection to GND.

Step 3: The EN pin should be left open for normal operation.

Step 4: Set the input source voltage to 12V and the load to 0.1A. The load voltage should be in regulation with a nominal 3.3V output.

Step 5: Slowly increase the load current while monitoring the load voltage at the V_O and GND terminals. It should remain in regulation with a nominal 3.3V output as the load is increased up to 10A.

Step 6: Slowly sweep the input source voltage over the operating voltage range corresponding to selected evaluation board as indicated in the introduction section. The load voltage should remain in regulation with a nominal 3.3V output.

Step 7: The shutdown function can be verified by applying 0V to the EN pin.

TESTING THE FIXED VERSION PARTS

The fixed output versions can also be mounted on the LM3150 evaluation boards with few modifications to the default configuration as indicated below. This is achievable because the pins 7 and 8 are not internally connected on the fixed version parts.

1. Replace U1, LM3150, with a fixed version part such as the LM3152
2. Short Rfb2
3. Remove Rfb1
4. Remove Cff

Ensure that the remaining components on the evaluation board will meet your design specifications by using the provided circuit calculator tools.

ALTERNATE RIPPLE INJECTION

Certain designs may benefit from another ripple injection technique that utilizes a resistor and capacitor to integrate the voltage across the inductor and then couple that signal through a capacitor to the FB pin. This technique is commonly found in COT controllers and may benefit designs that have high output voltage such as 12V and a low-side FET that has a low R_{DSON} and require low output voltage ripple. The evaluation board allows for this configuration allowing the placement of Rr, Cr, and Cac. After the proper components for Rr, Cr, and Cac have been chosen mount them on the evaluation board and remove Cff.

A quick efficiency check is the best way to confirm that everything is operating properly. If something is amiss you can be reasonably sure that it will affect the efficiency adversely. Few parameters can be incorrect in a switching power supply without creating losses and potentially damaging heat.

IMPROVING EFFICIENCY

It is also well known that efficiency may be improved slightly by placing a schottky diode across the low-side FET. The schottky diode has a much lower forward voltage drop than the internal diode of the FET and a faster turn-on time. This evaluation board allows for a schottky diode to be placed on footprint D1.

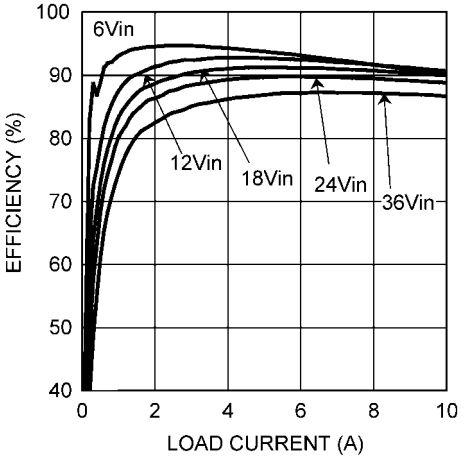
The internal VCC regulator provides a supply voltage to both the high-side and low-side FET drivers. The high-side FET driver receives it's supply voltage through a internal diode that has a forward voltage drop as high as 1V. This may impact the drivers ability to turn on the high-side FET fully and therefore cause a loss in efficiency depending upon which FET is chosen. The footprint Dbst allows for placement of a schottky diode that will have a much smaller forward drop and therefore increase the driver supply voltage and allow for improved efficiency for certain FETs.

OUTPUT VOLTAGE RIPPLE MEASUREMENT

The output voltage ripple measurement is usually taken directly across the output capacitors utilizing extremely short scope probe leads. To help make this measurement slightly easier, a footprint Cf has been included that will allow for a 1 µF or less 0805 or 1206 capacitor to be mounted directly across the output voltage terminals that will allow for approximate measurement of the ripple voltage.

Performance Characteristics

250 kHz Efficiency vs Load



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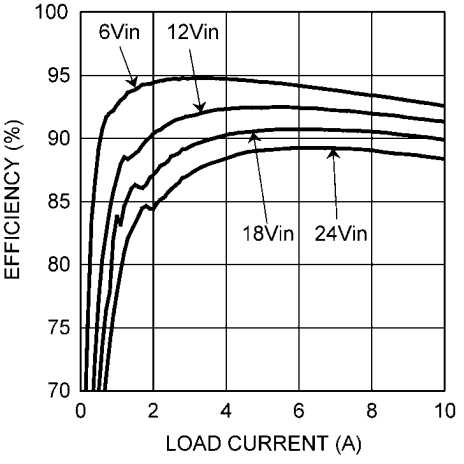
500 kHz Efficiency vs Load



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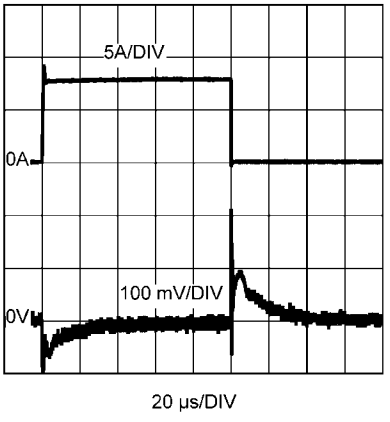
500 kHz Full Load Transient



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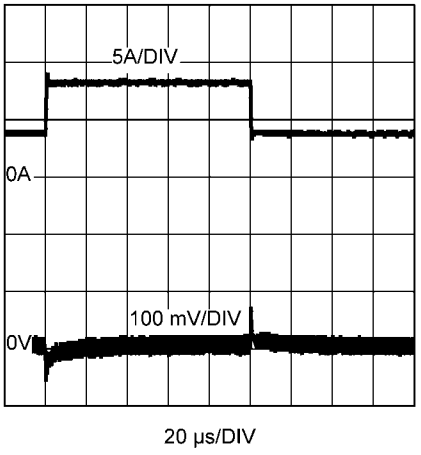
500 kHz Partial Load Transient



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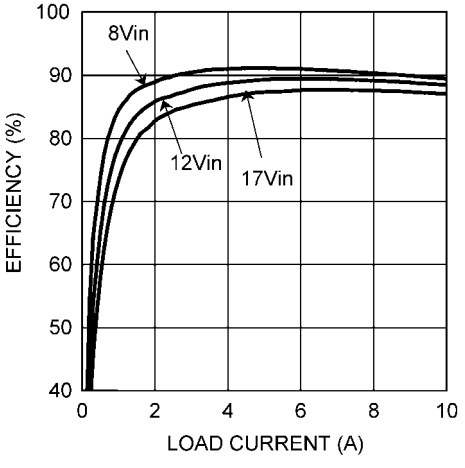
750 kHz Efficiency vs Load



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Full Schematic

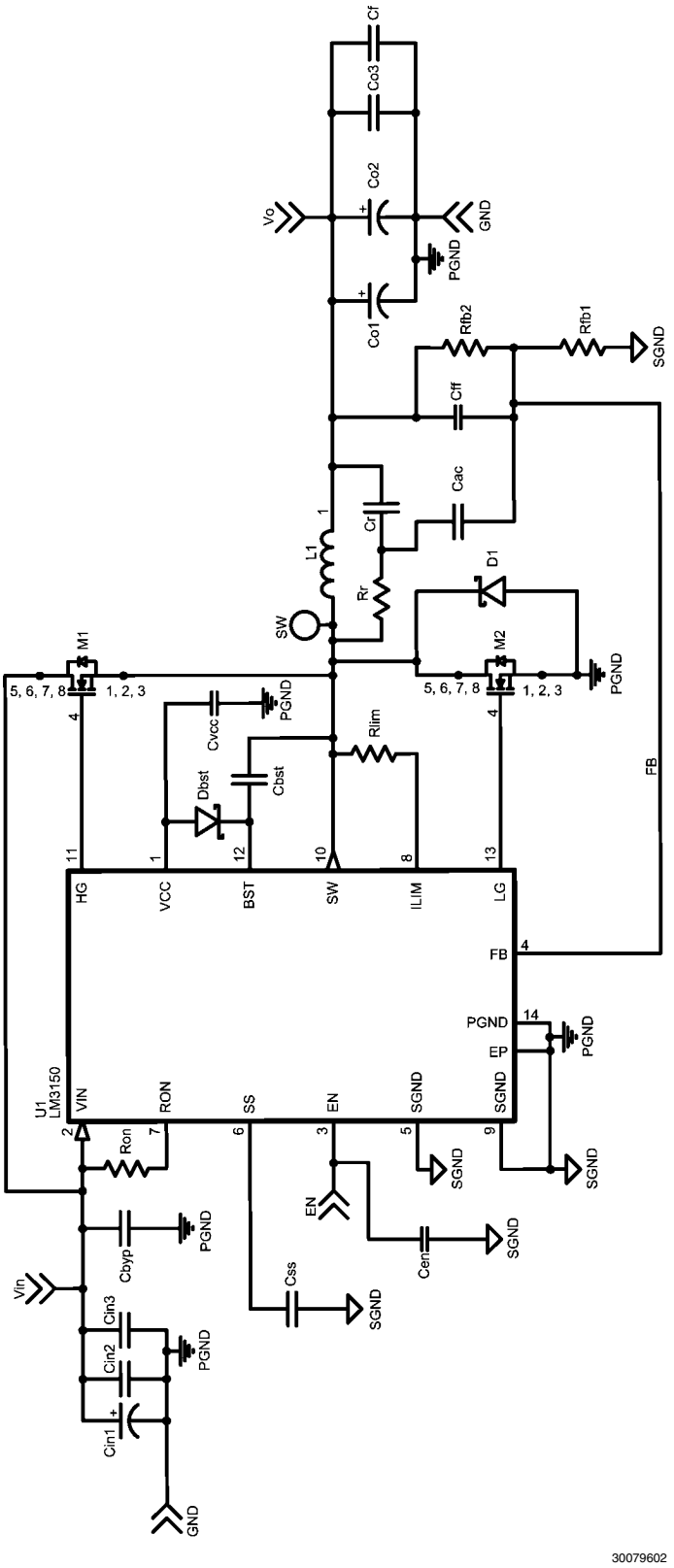


FIGURE 1. Full Evaluation Board Schematic

Layout and Bill of Materials

The Bill of Materials is shown below, including the manufacturer and part number.

TABLE 1. 250 kHz Bill of Materials

DESIGNATOR	QTY	PART NUMBER	DESCRIPTION	VALUE	VENDOR
U1	1	LM3150MH	Simple Switcher Controller	LM3150	National Semiconductor
Cbst	1	C2012X7R1C474K	Ceramic, X7R, 16V, 10%	0.47 µF	TDK
Cbyp	1	C2012X7R1H104K	Ceramic, X7R, 50V, 10%	0.100 µF	TDK
Cen	1	C1608X7R1H102K	Ceramic, X7R, 50V, 10%	1000 pF	TDK
Cff	1	VJ0805Y561KXACW1BC	Ceramic, X7R, 50V, 10%	560 pF	Vishay
Cin1, Cin2	2	50HVH56M	Aluminum Electrolytic, 50V, 20%	56 µF	Sanyo
Co1, Co2	2	PCF0J221MCL1GS	Polymer Aluminum, 6.3V, 20%	220 µF	Nichicon
Css	1	VJ0805Y683KXXA	Ceramic, 0805, 25V, 10%	0.068 µF	Vishay
Cvcc	1	C0805C105K4RACTU	Ceramic, X7R, 16V, 10%	1 µF	Kemet
EN	1	5002	Terminal, Single Pin	White	Keystone
L1	1	SER2013-362ML	Shielded Drum Core, 1.82 mΩ	3.6 µH	Coilcraft
M1	1	SI7850DP	NFET, $R_{DS(ON)}$ @4.5V=25 mΩ	60V	Vishay
M2	1	SI7478DP	NFET, $R_{DS(ON)}$ @4.5V=8.8 mΩ	60V	Vishay
PGND, PGND, Vin, Vo	4	1598-2	Turret Terminal	Triple	Keystone
Rfb1	1	CRCW08054K99FKEA	1%, 0.125W	4.99 kΩ	Vishay
Rfb2	1	CRCW080522K6FKEA	1%, 0.125W	22.6 kΩ	Vishay
Rlim	1	CRCW08051K40FKEA	1%, 0.125W	1.40 kΩ	Vishay
Ron	1	CRCW0805115KFKEA	1%, 0.125W	115 kΩ	Vishay
SW	1	5015	Surface Mount Test Point		Keystone
Rr, Cr, Cin3, Cac, Dbst, D1			Not Installed, See Text		

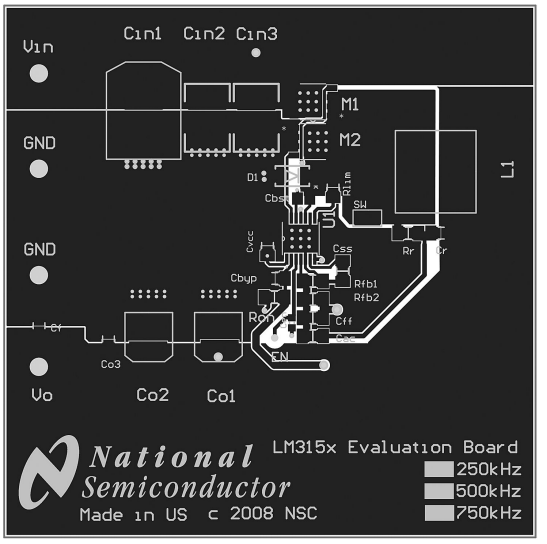
TABLE 2. 500 kHz Bill of Materials

DESIGNATOR	QTY	PART NUMBER	DESCRIPTION	VALUE	VENDOR
U1	1	LM3150MH	Simple Switcher Controller	LM3150	National Semiconductor
Cbst	1	C2012X7R1C474K	Ceramic, X7R, 16V, 10%	0.47 µF	TDK
Cbyp	1	C2012X7R1H104K	Ceramic, X7R, 50V, 10%	0.100 µF	TDK
Cen	1	C1608X7R1H102K	Ceramic, X7R, 50V, 10%	1000 pF	TDK
Cff	1	VJ0805A271JXACW1BC	Ceramic, X7R, 50V, 10%	270 pF	Vishay
Cin1	1	EEVFK1J101P	Aluminum Electrolytic, , 63V, 20%	100 µF	Panasonic
Cin2, Cin3	2	GMK325BJ106KN-T	Ceramic, X7R, 50V, 20%	10 µF	Taiyo Yuden
Co1, Co2	2	EEF-UE0J151R	Polymer Aluminum, 6.3V, 20%	150 µF	Panasonic
Css	1	VJ0805Y683KXXA	Ceramic, 0805, 25V, 10%	0.068 µF	Vishay
Cvcc	1	C0805C105K4RACTU	Ceramic, X7R, 16V, 10%	1 µF	Kemet
EN	1	5002	Terminal, Single Pin	White	Keystone
L1	1	MVR1271C-162ML	Shielded Drum Core, 2.53 mΩ	1.65 µH	Coilcraft
M1,M2	2	RJK0305DPB	NFET, $R_{DS(ON)}$ @4.5V=10 mΩ	30V	Renesas
PGND, PGND, Vin, Vo	4	1598-2	Turret Terminal	Triple	Keystone
Rfb1	1	CRCW08054K99FKEA	1%, 0.125W	4.99 kΩ	Vishay
Rfb2	1	CRCW080522K6FKEA	1%, 0.125W	22.6 kΩ	Vishay
Rlim	1	CRCW08051K91FKEA	1%, 0.125W	1.91 kΩ	Vishay
Ron	1	CRCW080556K2FKEA	1%, 0.125W	56.2 kΩ	Vishay
SW	1	5015	Surface Mount Test Point		Keystone
Rr, Cr, Cac, Dbst, D1			Not Installed, See Text		

TABLE 3. 750 kHz Bill of Materials

DESIGNATOR	QTY	PART NUMBER	DESCRIPTION	VALUE	VENDOR
U1	1	LM3150MH	Simple Switcher Controller	LM3150	National Semiconductor
Cbst	1	C2012X7R1C474K	Ceramic, X7R, 16V, 10%	0.47 µF	TDK
Cbyp	1	C2012X7R1H104K	Ceramic, X7R, 50V, 10%	0.100 µF	TDK
Cen	1	C1608X7R1H102K	Ceramic, X7R, 50V, 10%	1000 pF	TDK
Cff	1	CC0805JRNP09BN151	Ceramic, NP0, 50V, 5%	150 pF	Yageo
Cin1	1	EEE-FK1V151P	Aluminum Electrolytic, 63V, 20%	150 µF	Panasonic
Cin2, Cin3	2	GMK325BJ106KN-T	Ceramic, X7R, 50V, 20%	10 µF	Taiyo Yuden
Co1, Co2	2	EEF-UE0J151R	Polymer Aluminum, 6.3V, 20%	150 µF	Panasonic
Css	1	VJ0805Y683KXXA	Ceramic, 0805, 25V, 10%	0.068 µF	Vishay
Cvcc	1	C0805C105K4RACTU	Ceramic, X7R, 16V, 10%	1 µF	Kemet
EN	1	5002	Terminal, Single Pin	White	Keystone
L1	1	XPL7030-102ML	Shielded Drum Core, 1.9 mΩ	1 µH	Coilcraft
M1	1	RJK0305DPB	NFET, $R_{DS(ON)}$ @4.5V=10 mΩ	30V	Renesas
M2	1	RJK0329DPB	NFET, $R_{DS(ON)}$ @4.5V=2.4 mΩ	30V	Renesas
PGND, PGND, Vin, Vo	4	1598-2	Turret Terminal	Triple	Keystone
Rfb1	1	CRCW08054K99FKEA	1%, 0.125W	4.99 kΩ	Vishay
Rfb2	1	CRCW080522K6FKEA	1%, 0.125W	22.6 kΩ	Vishay
Rlim	1	CRCW08051K91FKEA	1%, 0.125W	1.91 kΩ	Vishay
Ron	1	CRCW080556K2FKEA	1%, 0.125W	56.2 kΩ	Vishay
SW	1	5015	Surface Mount Test Point		Keystone
Rr, Cr, Cac, Dbst, D1			Not Installed, See Text		

PCB Layout



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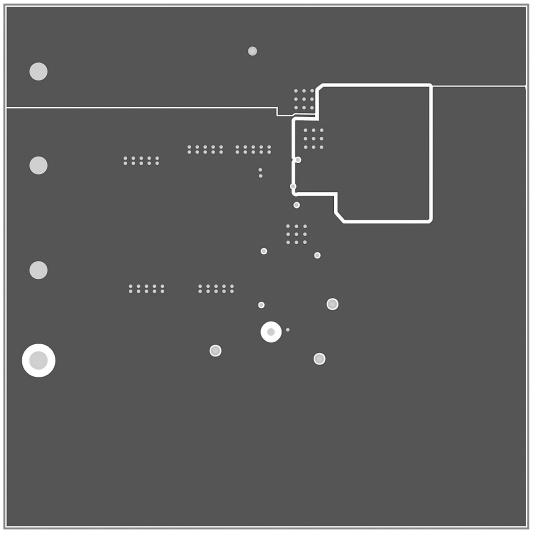
Top Layer



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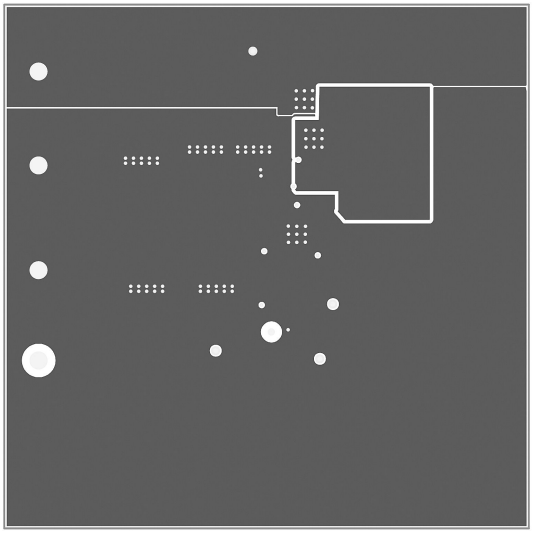
Inner Copper 1



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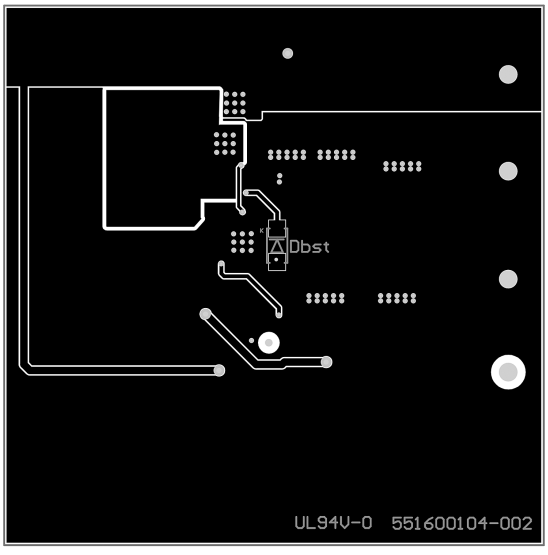
Inner Copper 2



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Bottom Layer Viewed From Bottom Side

Notes

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