

ON Semiconductor

Is Now

onsemi™

To learn more about onsemi™, please visit our website at
www.onsemi.com

onsemi and **onsemi** and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi** product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner. Other names and brands may be claimed as the property of others.



Is Now Part of



ON Semiconductor®

To learn more about ON Semiconductor, please visit our website at
www.onsemi.com

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

User Guide for
FEBFDMQ86530L
Evaluation Board

GreenBridge™ of High-Efficiency
Bridge Rectifiers Quad N-Channel
PowerTrench® MOSFETS

Featured Fairchild Product:
FDMQ86530L

*Direct questions or comments
about this evaluation board to:
“Worldwide Direct Support”*

Fairchild Semiconductor.com

Table of Contents

1. Evaluation Board Specifications.....	3
2. Photographs.....	4
3. Printed Circuit Board	5
4. Schematic	6
5. Bill of Materials	6
6. Test Setup.....	7
6.1. Test Equipment	7
6.2. Test Setup.....	7
7. Measured Data	8
7.1. Thermal Images.....	10
7.2. Waveforms	10
8. Revision History	11

This user guide supports the evaluation kit for the FDMQ86530L. It should be used in conjunction with the FDMQ86530L datasheet as well as Fairchild's application notes and technical support team. Please visit Fairchild's website at www.fairchildsemi.com.

This document describes the evaluation kit for the GreenBridge™ FDMQ86530L integrated quad 60 V N-channel MOSFET in an MLP 4.5 x 5 package. The FDMQ86530L replaces a conventional diode bridge in AC 24 V rectifier applications by reducing the power dissipation and reducing thermal problems.

1. Evaluation Board Specifications

- Board laminate: FR-360HR
- Cu layer count: 4-layer
- Board thickness: 1.6 mm
- Inter layer Cu thickness: 2 oz.
- Via hole minimum plating: 20 μm
- Outer layer Cu thickness: 2 oz.
- Solder mask is concentric with holes per standard specification
- Gold immersion
- Non-conductive ink silkscreen

Table 1. Summary of Features and Performance

Parameter	Value	Remark
GreenBridge™	FDMQ86530L	Quad 60 V N-channel PowerTrench® MOSFETs, Fairchild Semiconductor
Controller		Bridge Controller
V _{IN} Range		9 V _{AC} ~ 42 V _{AC}
Switching Frequency		60 Hz
Max. I _{OUT}	5 A	Limited by Power component

Table 2. MOSFET Parameters

Part Number	Location	BV _{DSS} (V)	I _D T _A =25°C	Typ. R _{DS(ON)} at 10 V _{GS}	Typ. Q _g at 10 V _{GS}
FDMQ86530L	Q1, Q2, Q3, Q4	60	8 A	12 mΩ	23 nC

The board dimensions are 100 mm x 75 mm. Figure 1 shows the physical information of the individual layers.

		1.6T
Copper	1	0.07
Pre-preg		0.18
Copper	2	0.07
C.C.L		1.0
Copper	3	0.07
Pre-Preg		0.18
Copper	4	0.07
Total Thickness		1.64T

Figure 1. Board Construction

2. Photographs

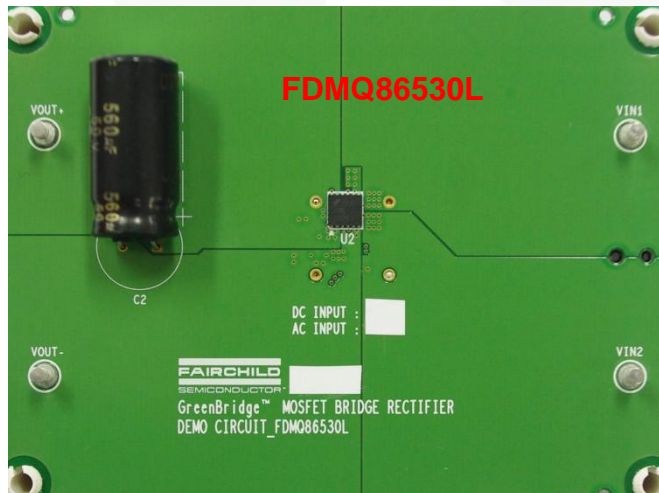


Figure 2. Top View

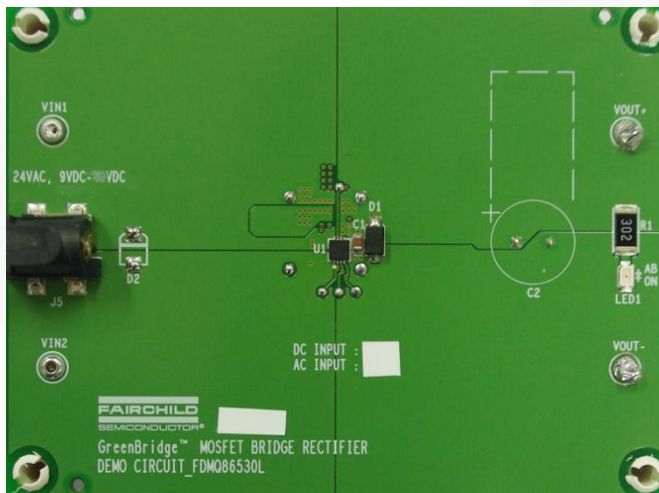


Figure 3. Bottom View

3. Printed Circuit Board

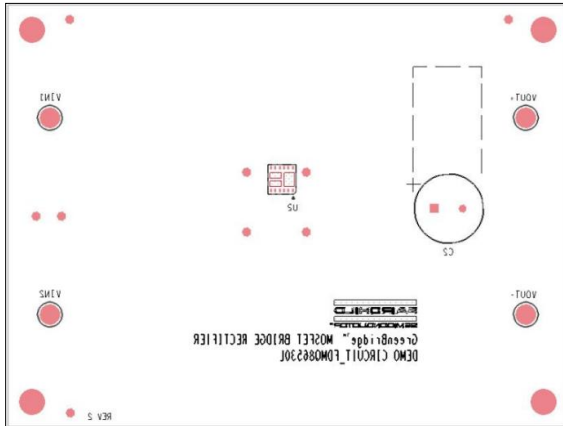


Figure 4. SST and SMT Top Side
(Size = 100 X 75 mm, 4 Layer)

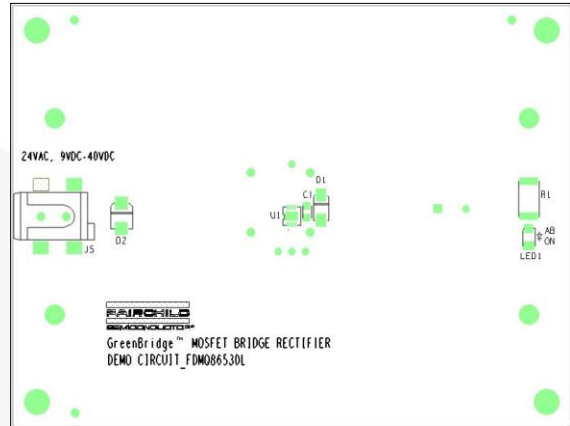


Figure 5. SSB and SMB Bottom Side

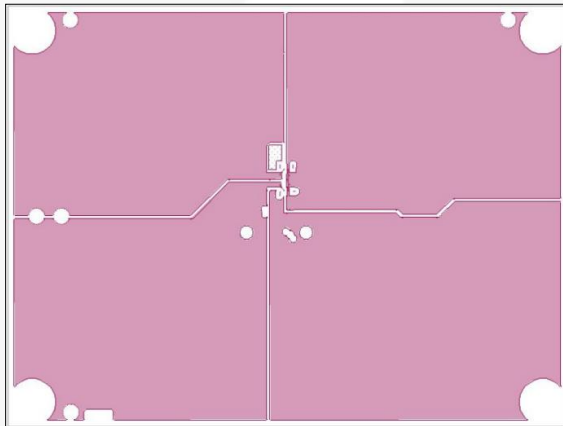


Figure 6. Top Layer

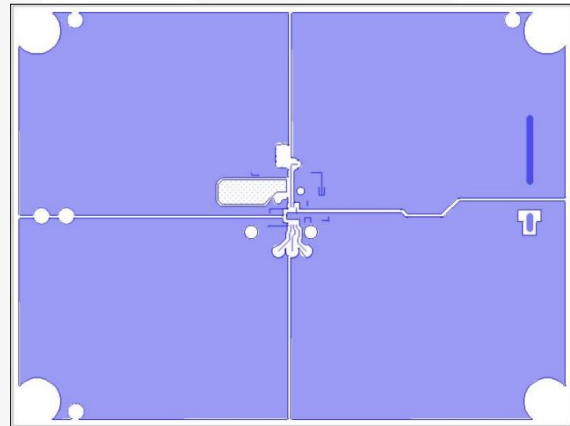


Figure 7. Bottom Layer

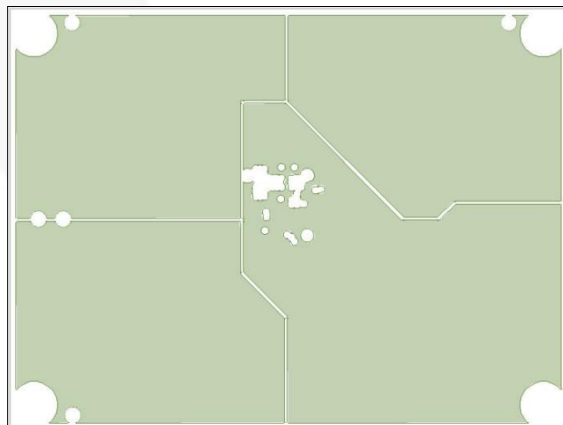


Figure 8. Power Layer

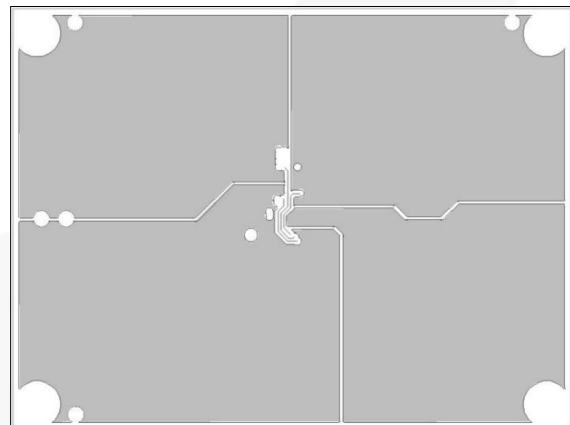


Figure 9. Ground Layer

4. Schematic

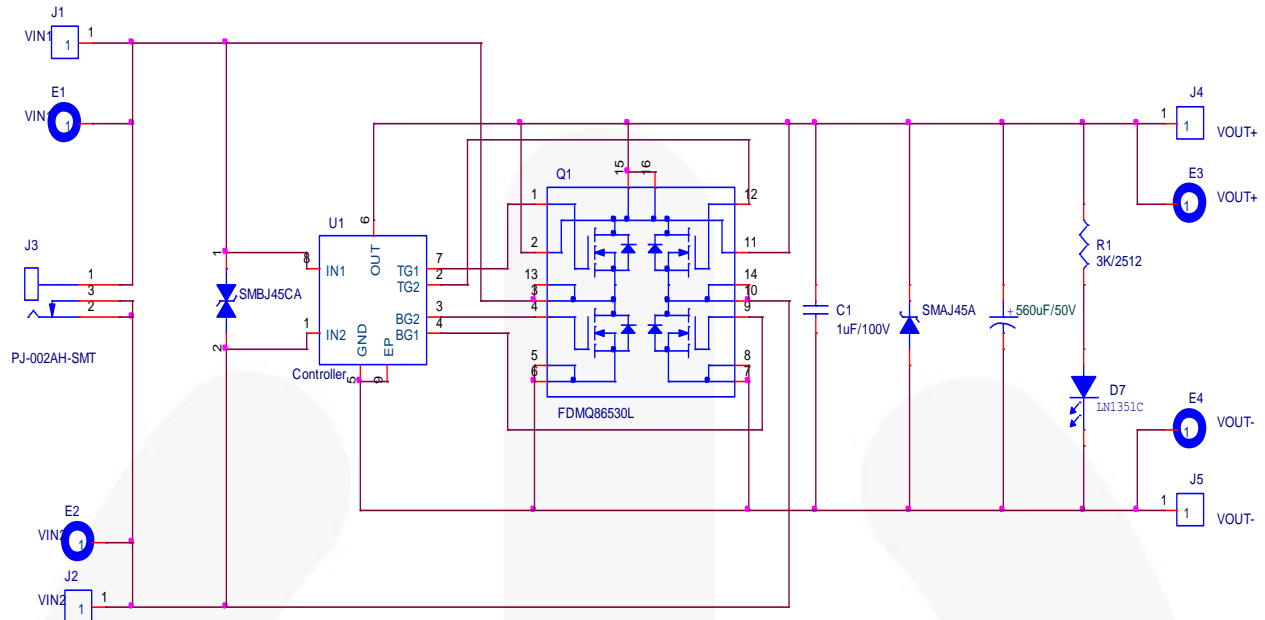


Figure 10. Evaluation Board Schematic

5. Bill of Materials

Item	Qty.	Reference	Part Name	Vendor	Comment
1	1	C1	C2012X7S2A105K	TDK	1 μ F / 100 V / 2012
2	1	C2	EEU-FM1H561	Panasonic	560 μ F / 50 V /ALU
3	1	D1	SMAJ45A-13-F	Diodes	TVS UNIDIRECT 400 W 45 V SMA
4	1	D2	SMBJ45CA-13-F	Diodes	TVS BIDIRECT 600 W 45 V SMB
5	4	E1-E4	2501-2-00-80-00-00-07-0	Mill-Max	Test Pin
6	1	J5	PJ-002A-SMT	CUI INC.	POWER JACK 2.1 x 5.5 mm
7	1	LED1	LN1351CTR	Panasonic	GREEN J-TYPE SMD
8	1	R1	CRCW25123K00JNEG	VISHAY	3 k Ω , 5% 2512
9	1	U1	LT4320IDDE	LINEAR TECH.	IC
10	1	U2	FDMQ86530L	Fairchild Semiconductor	60 V N-Channel MOSFET GreenBridge™
11	4	MH1-MH4	8833 (SNAP ON)	KEYSTONE	NYLON 0.50" Tall

6. Test Setup

6.1. Test Equipment

- 0 – 50V_{AC} / 5 A AC power supply for input voltage
- Oscilloscope to view waveforms

6.2. Test Setup

- AC V_{IN} power supply adjusted and connected to VIN1 (J1) and VIN2 (J2)

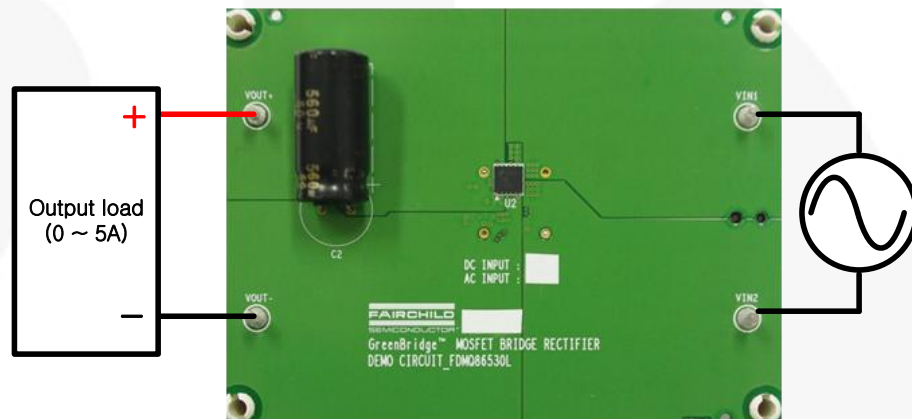


Figure 11. AC GreenBridge™ FDMQ86530L Test Setup

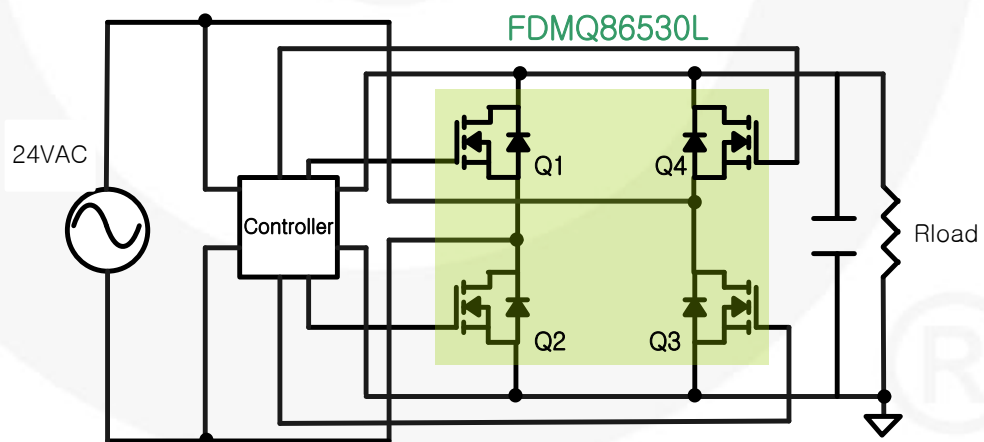


Figure 12. Test Diagram

7. Measured Data

Figure 13 - Figure 15 show the measured thermal performance of the GreenBridge™ FDMQ8650L compared with B360B diode bridge on the evaluation board. Figure 16 shows the thermal image at 5 A of output current.

Table 3. Test Condition

V_{IN}	f_{SW}	I_{OUT}	Cooling
24 V _{AC}	60 Hz	0-5 A, 0.5 A Step, 5 min. Soak Time	No

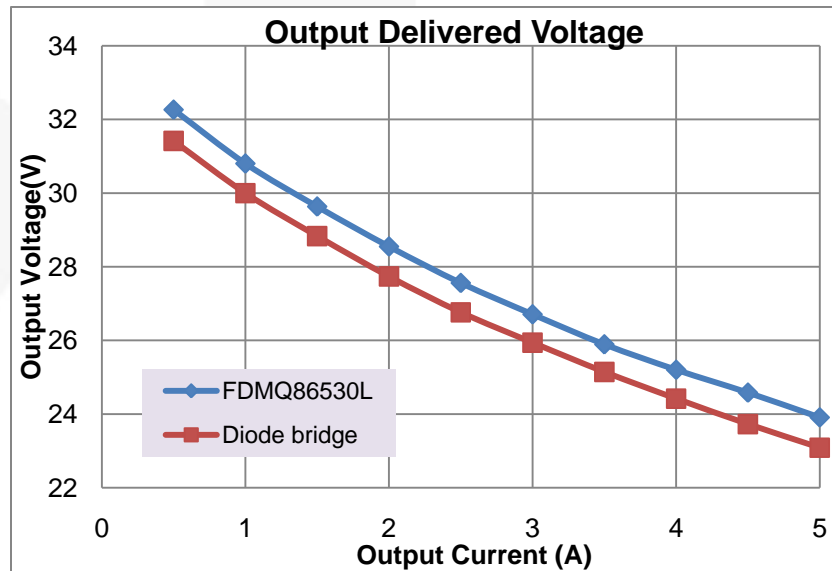


Figure 13. Output Delivered Voltage at $T_A=25^\circ\text{C}$, Natural Air Flow

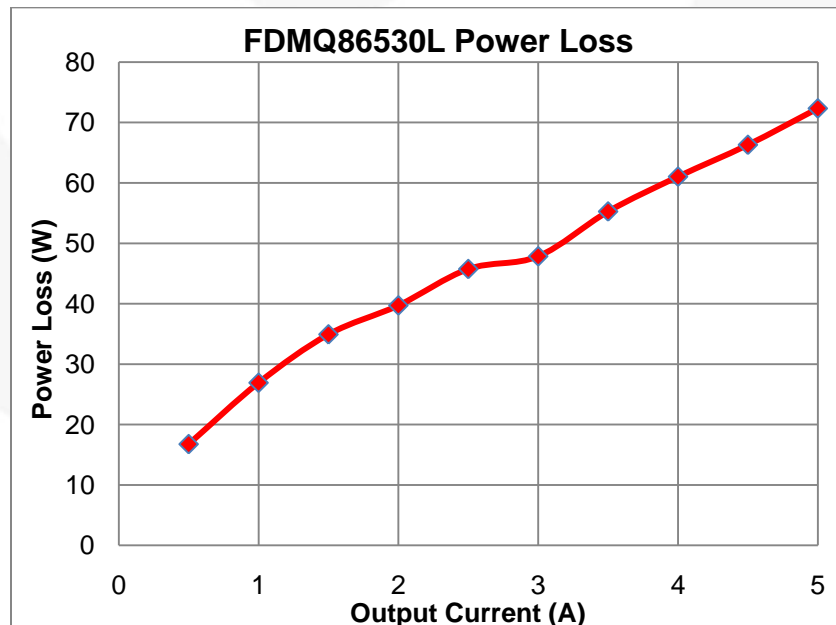


Figure 14. Power Dissipation at $T_A=25^\circ\text{C}$, Natural Air Flow

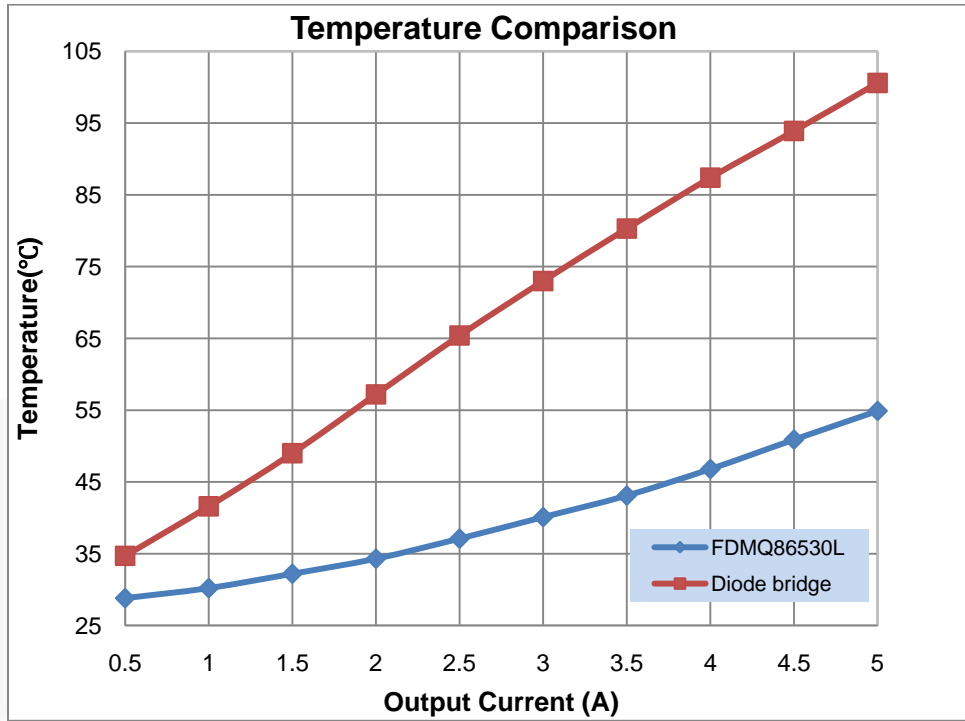


Figure 15. Thermal Performance at $T_A=25^{\circ}\text{C}$, Natural Air Flow

7.1. Thermal Images

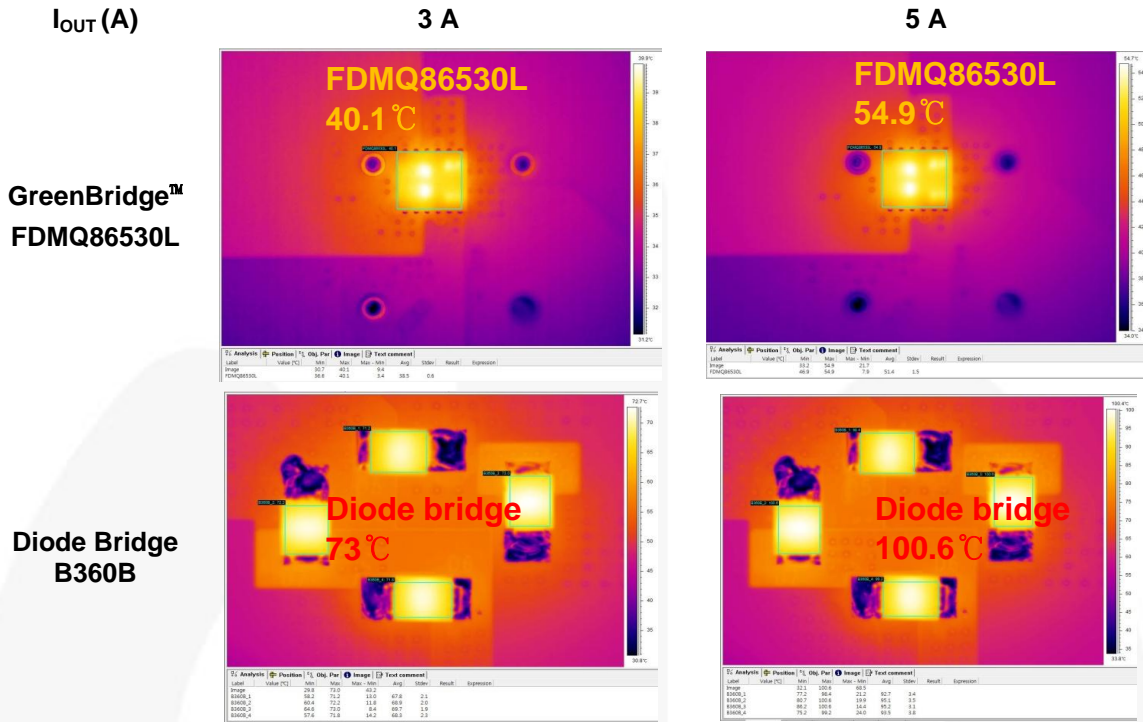


Figure 16. Thermal Performance at $V_{IN} = 24 V_{AC} / 60Hz$, $T_A=25^{\circ}C$, Natural Air Flow

7.2. Waveforms

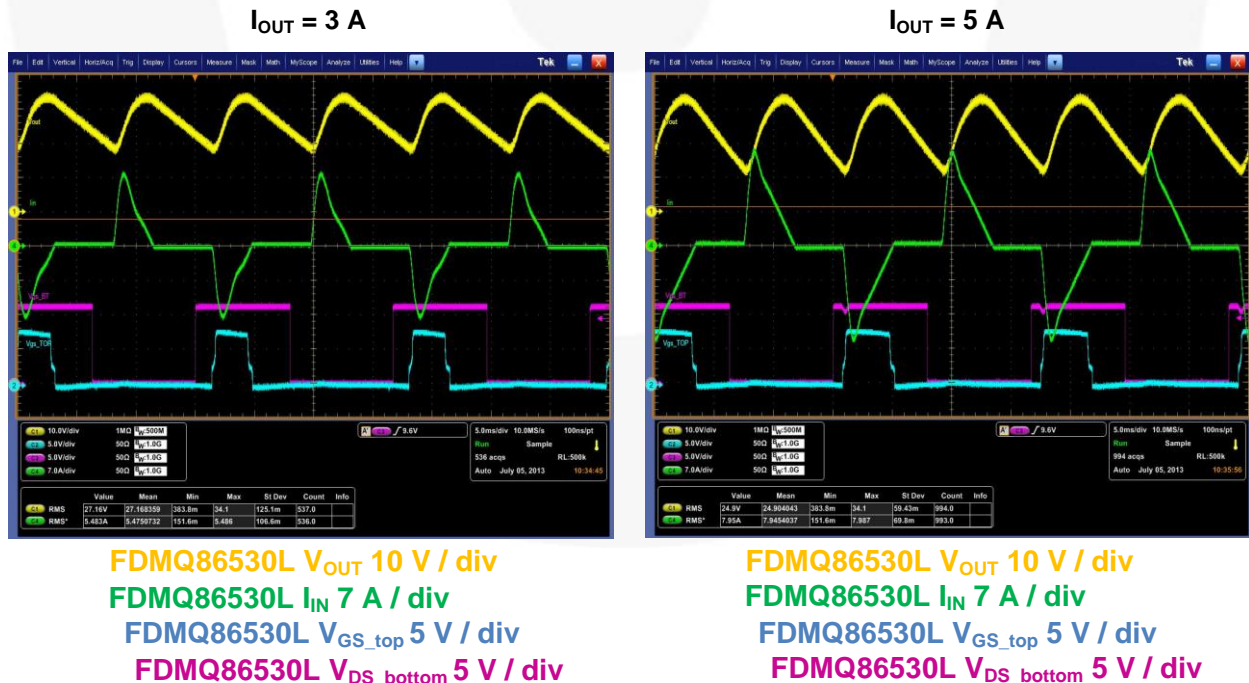


Figure 17. Switching Waveforms at $V_{IN} = 24 V_{AC} / 60 Hz$, $T_A=25^{\circ}C$, Natural Air Flow

8. Revision History

Rev.	Date	Description
1.0.0	October 2013	Initial Release

WARNING AND DISCLAIMER

Replace components on the Evaluation Board only with those parts shown on the parts list (or Bill of Materials) in the Users' Guide. Contact an authorized Fairchild representative with any questions.

This board is intended to be used by certified professionals, in a lab environment, following proper safety procedures. Use at your own risk. The Evaluation board (or kit) is for demonstration purposes only and neither the Board nor this User's Guide constitute a sales contract or create any kind of warranty, whether express or implied, as to the applications or products involved. Fairchild warrants that its products meet Fairchild's published specifications, but does not guarantee that its products work in any specific application. Fairchild reserves the right to make changes without notice to any products described herein to improve reliability, function, or design. Either the applicable sales contract signed by Fairchild and Buyer or, if no contract exists, Fairchild's standard Terms and Conditions on the back of Fairchild invoices, govern the terms of sale of the products described herein.

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

- | | |
|---|---|
| <p>1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.</p> | <p>2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.</p> |
|---|---|

ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

EXPORT COMPLIANCE STATEMENT

These commodities, technology, or software were exported from the United States in accordance with the Export Administration Regulations for the ultimate destination listed on the commercial invoice. Diversion contrary to U.S. law is prohibited.

U.S. origin products and products made with U.S. origin technology are subject to U.S. Re-export laws. In the event of re-export, the user will be responsible to ensure the appropriate U.S. export regulations are followed.

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81-3-5817-1050

ON Semiconductor Website: www.onsemi.com
Order Literature: <http://www.onsemi.com/orderlit>
For additional information, please contact your local
Sales Representative