

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

Please note: As part of the Fairchild Semiconductor integration, some of the Fairchild orderable part numbers will need to change in order to meet ON Semiconductor's system requirements. Since the ON Semiconductor product management systems do not have the ability to manage part nomenclature that utilizes an underscore (_), the underscore (_) in the Fairchild part numbers will be changed to a dash (-). This document may contain device numbers with an underscore (_). Please check the ON Semiconductor website to verify the updated device numbers. The most current and up-to-date ordering information can be found at www.onsemi.com. Please email any questions regarding the system integration to Fairchild_questions@onsemi.com.

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 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 consulting with 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

Class 3 medical devices or medical devices with the same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use



FAN8841

Dual Half-Bridge Piezoelectric Driver with Step-up DC-DC Converter

Features

Step-up DC-DC Converter

- Integrated Step-up Power Switch up to 36 V
- Wide Operat



Typical Application

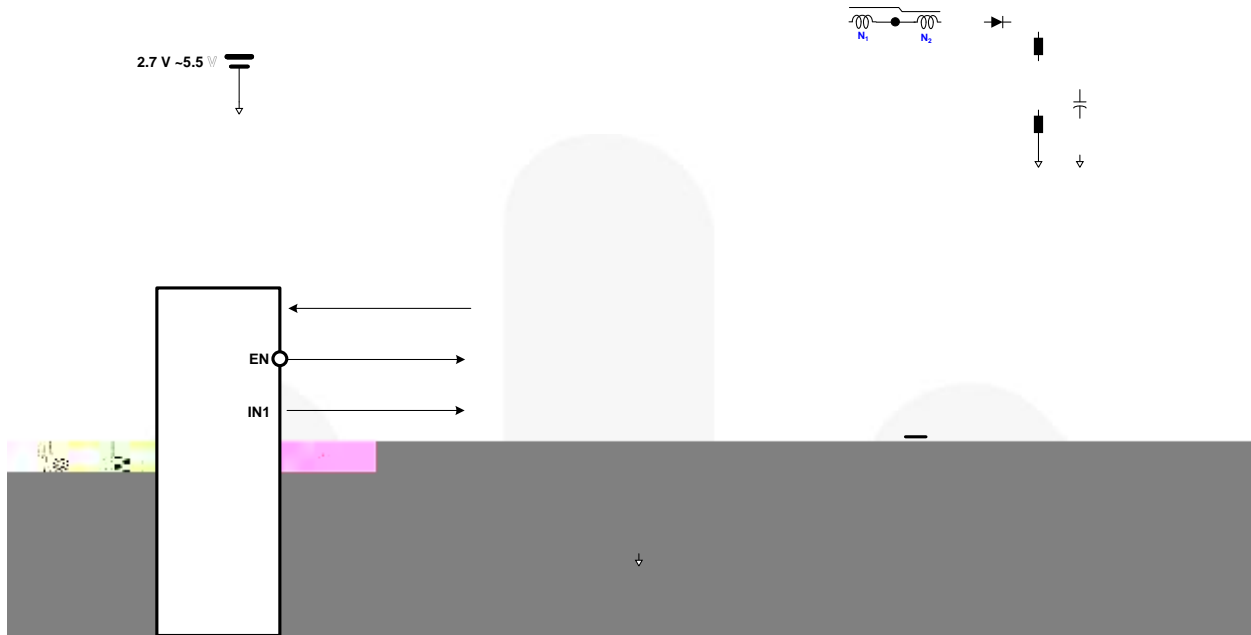


Figure 1. Typical Application Circuit for Piezo Actuator Driver

Block Diagram



Figure 2. Block Diagram

Pin Configuration

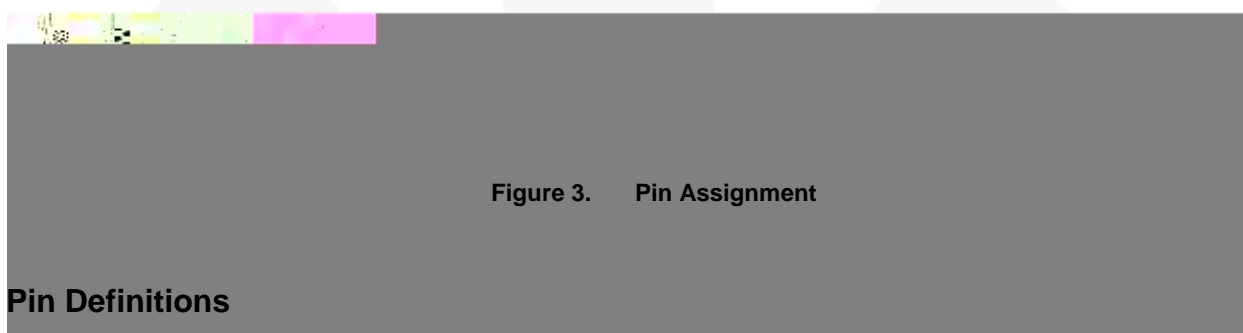


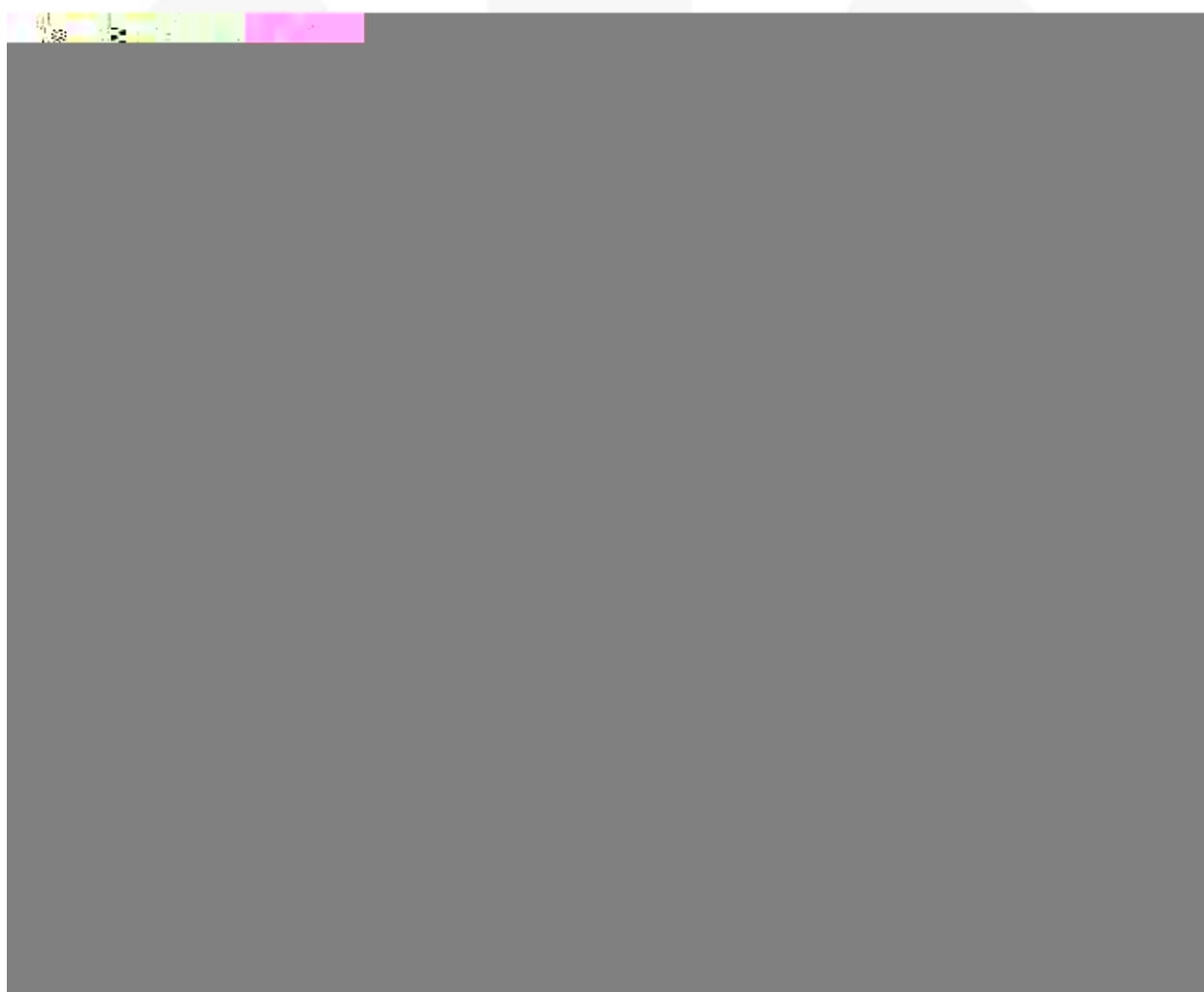
Figure 3. Pin Assignment

Pin Definitions

Pin #	Name	Description
1, 2	PGND1	Power Ground 1. It is connected to the source of the step-up switch.
3	V _{DD}	Power supply of step-up DC-DC converter.
4	SGND	Signal Ground. The signal ground for step-up DC-DC converter circuitry.
5	ZCD	The input of the Zero Current Detection
6	FB	Step-up DC-DC converter output voltage feedback input.
7	COMP	Output of the transconductance error amplifier.
8	OCP	Sets Step-up DC-DC converter current limit
9	FO	Fault Output.
10	EN	Enable pin to turn on and off the overall system. (Active Low Shutdown Mode2 284.57 3(t)11(h))

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended.



Electrical Characteristics

$V_{DD}=3.0\text{ V}$, $V_{DRV}=60\text{ V}$, and $T_A=-40^\circ\text{C}$ to $+125^\circ\text{C}$. Typical values $T_A=25^\circ\text{C}$, unless otherwise specified.

Symbol	Parameter	Conditions
--------	-----------	------------



Electrical Characteristics

$V_{DD}=3.0\text{ V}$, $V_{DRV}=60\text{ V}$, and $T_A=-40^\circ\text{C}$ to $+125^\circ\text{C}$. Typical values $T_A=25^\circ\text{C}$, unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Current Limit Comparator Section						
I _{OCP}	OCP Trip Current	R _{OCP} =3.3 K , V _{DD} =3.3 V	1.85	2.00	2.15	A
		R _{OCP} =22 K , V _{DD} =3.3 V	0.9	1.0	1.1	A
t _{CS_BLANK}	Comparator Leading-Edge Blanking Time ⁽⁸⁾		80	130	180	ns
Step-up Output Control Section						
I _{CON}	Internal Current Source for V _{CON} Pin	T _A =25°C	9.0	10	11	μA
V _{CON+}	Positive Going Threshold Voltage ⁽⁸⁾			1.0		V
V _{CON-}	Negative Going Threshold Voltage ⁽⁸⁾			0.1		V

Step-up Switch.48 refW52.0





Typical Performance Characteristics

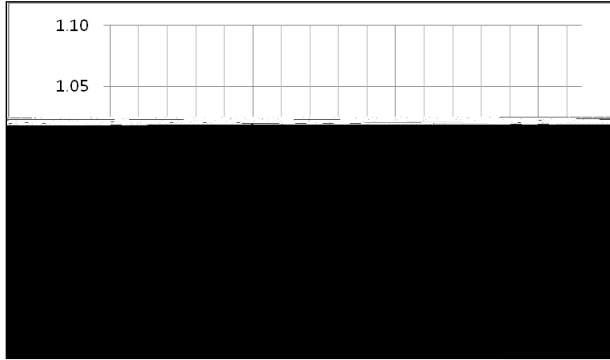


Figure 5. Reference Voltage vs. Temperature

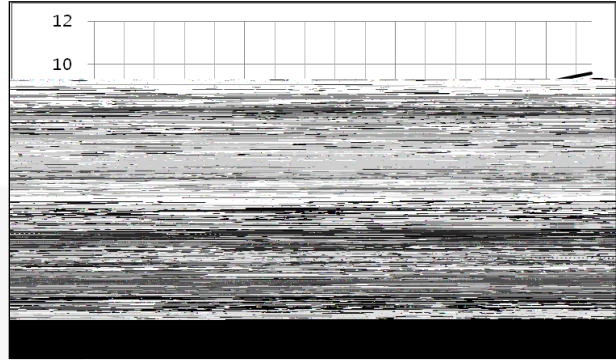


Figure 6. Shutdown Current for V_{DD} & V_{DRV} vs. Temperature

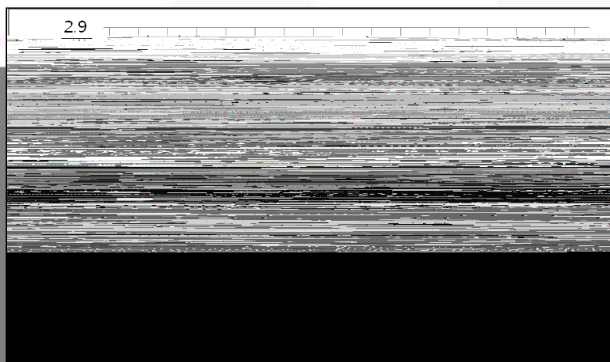


Figure 7. V_{DD} Threshold vs. Temperature

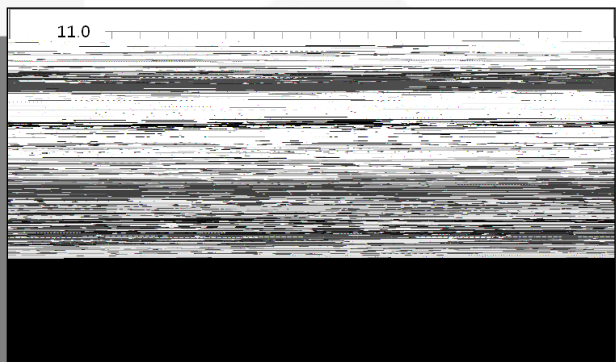


Figure 8. V_{CON} Current vs. Temperature

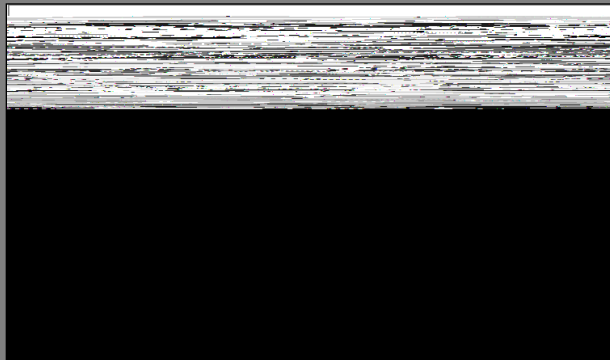


Figure 9. Quiescent Current for V_{DD} & V_{DRV} vs. Temperature



Figure 10. OCP Current vs. Temperature

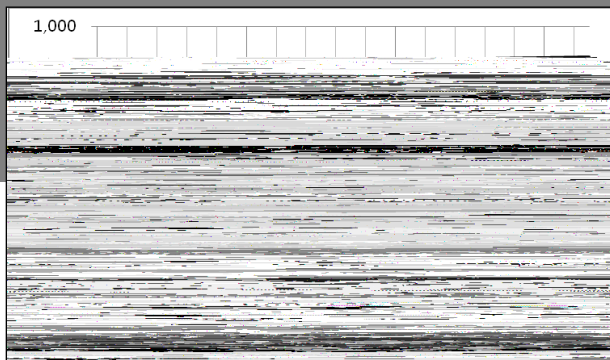


Figure 11. Operating Current for V_{DD} , V_{DRV} , & V_{IN}

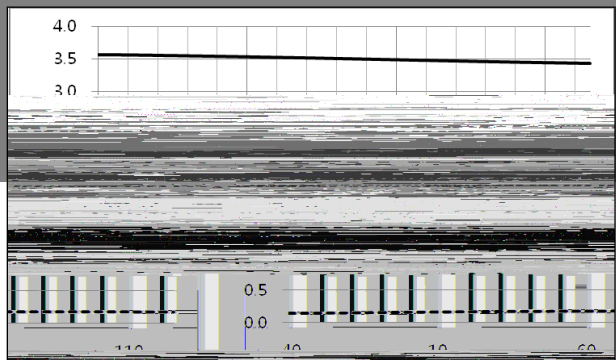


Figure 12. ZDC Clamp Voltage vs. Temperature

vs. Temperature

Typical Performance Characteristics (Continued)

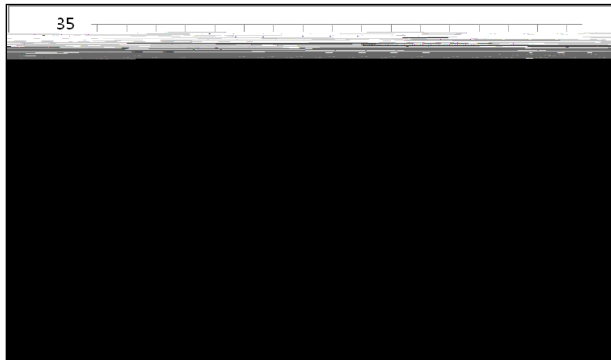


Figure 13. Maximum On-Time vs. Temperature

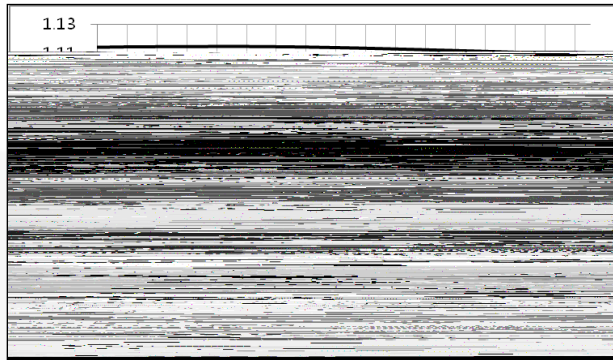


Figure 14. OVP (FB) vs. Temperature

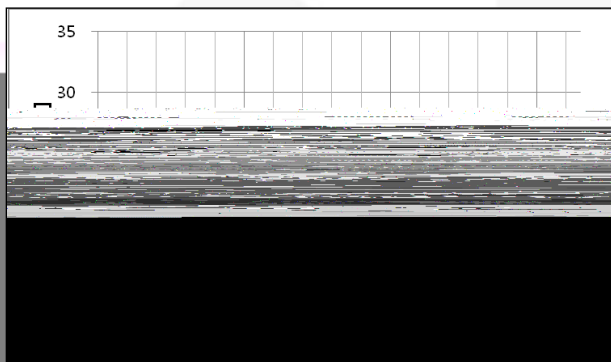


Figure 15. Restart-Time vs. Temperature

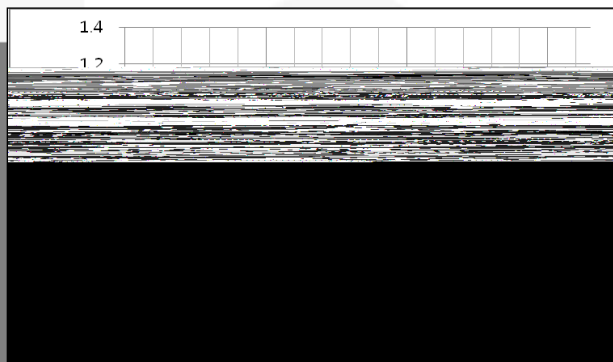


Figure 16. INPUT Threshold vs. Temperature

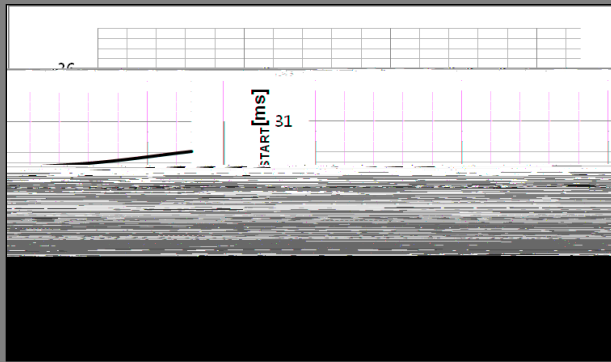


Figure 17. Soft-Start Time vs. Temperature

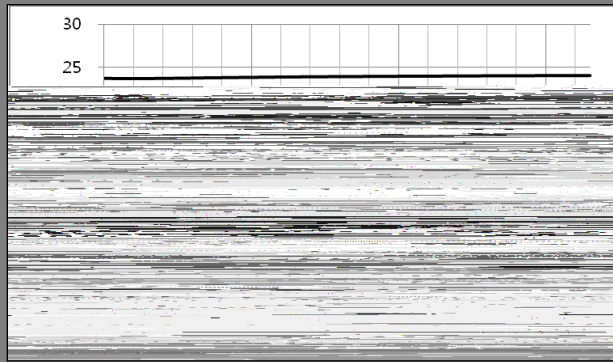


Figure 18. INPUT Logic Current vs. Temperature

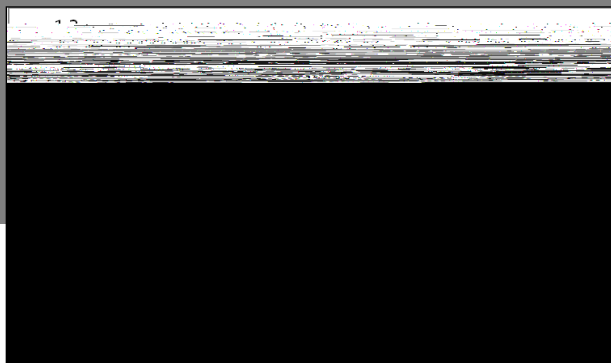


Figure 19. Enable(EN) Threshold Voltage vs. Temperature

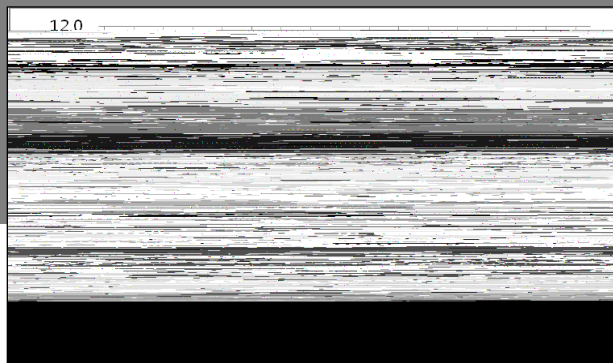


Figure 20. V_{DRV} UVP Threshold Voltage vs. Temperature

Typical Performance Characteristics (Continued)

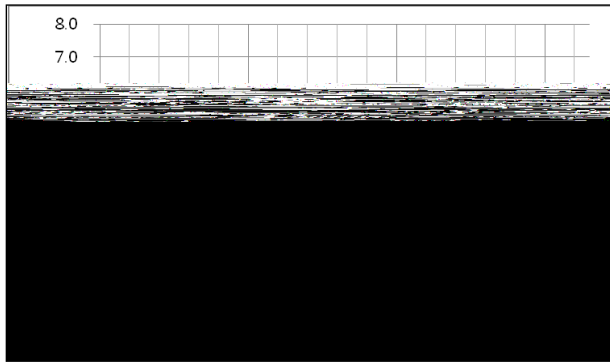


Figure 21. Half-Bridge Switch $R_{DS(on)}$ vs. Temperature

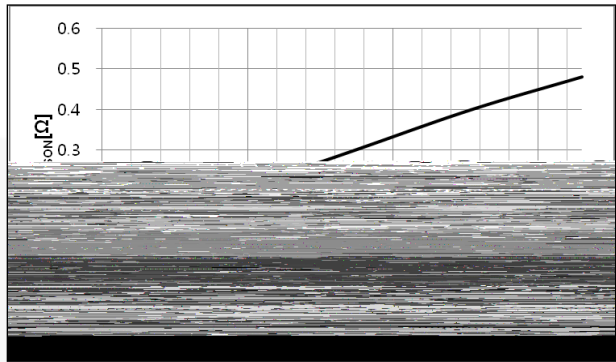


Figure 22. Boost Switch $R_{DS(on)}$ vs. Temperature

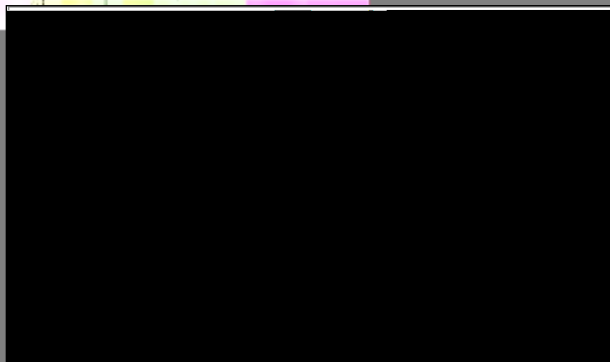


Figure 23. OUT1/2 Delay vs. V_{DRV}

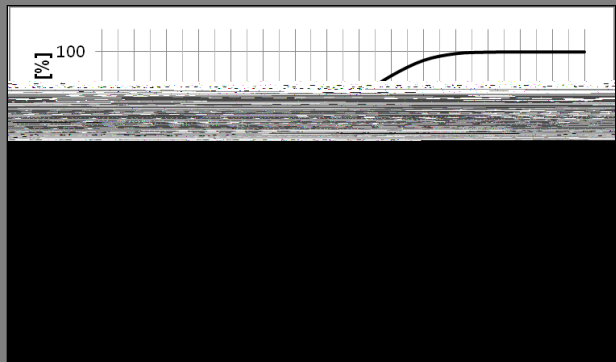


Figure 24. % of OUT Amplitude vs. V_{CON}

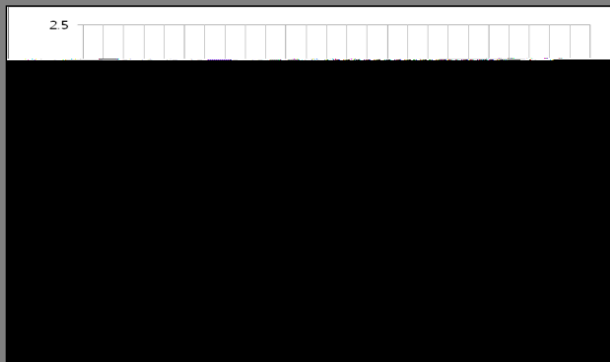



Figure 25. I_{OCP} vs. R_{OCP}

Functional Description

The FAN8841 has a basic PWM controller for Step-up DC-DC converter topology in Critical Conduction Mode (CRM) and integrated Dual half-bridge drivers. To increase efficiency of the DC-DC converter, FAN8841 has a Zero Current Detection (ZCD) function for CRM control. It can reduce Step-up DC-DC converter switching loss at MOSFET turn on time. The FAN8841 Step-up DC-DC converter supports output voltage up to 36 V with the use of a commercial inductor since the absolute maximum voltage of internal switching FET V_{DS} is 40 V. If the use requires a driving voltage higher than 36 V, it is recommended to use a coupled inductor, since the internal half-bridge absolute maximum voltage is 75 V.

The device architecture is that of a current mode controller with an internal sensing resistor connected in series with the NMOS switch. The voltage at the feedback pin tracks the output voltage at the cathode of the external Schottky diode. The internal error amplifier amplifies the difference between the feedback voltage and the internal reference voltage. I



V_{DRV} Under-Voltage Protection

The driving voltage of the internal dual Half-bridge is received from the V_{DRV} pin. The internal 5 V LDO for driving the internal gate driver is also received from the V_{DRV} pin. For supplying a stable power to the internal gate driver, V_{DRV} has an under-voltage protection function. If the V_{DRV} voltage is less than 11 V typically, during normal operation, the internal gate driver is turned off. When the V_{DRV} voltage exceeds 12 V typically, the internal gate driver is turned on.

Over-Voltage Protection (OVP)

The FAN8841 features a unique V_{DRV} monitoring to maximize the safety when the feedback voltage is higher than the specified threshold voltage. The OVP comparator shuts down the output drive block when the voltage of the FB pin is higher than 1.1 V.

At the normal operating condition, Fault Out signal maintains on V_{DD} voltage, but the abnormal over-voltage has occurred at V_{DRV}, Fault Out signal goes low during typ. 20 μs.

Application information

Setting the Output Voltage

The internal reference is 1.0 V (Typical) and it controlled by the V_{CON} voltage. The output voltage is divided by the external resistor divider, R_{FB1} and R_{FB2} to the FB pin. The output voltage is given by:

$$V_{DRV} = V_{REF} \left(1 + \frac{R_{FB1}}{R_{FB2}} \right) \quad (2)$$

Figure 27. Feedback Circuit

Inductor Selection

To prevent the absolute maximum voltage in the operating condition, the switching voltage V_{LX} should be lower than 36 V, as shown in Figure 28.

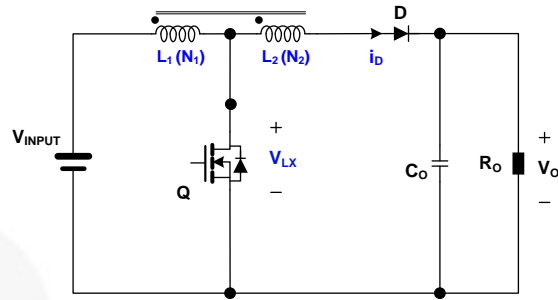


Figure 28. Schematic of Coupled Inductor Boost Converter

V_{LX} is determined by the output voltage, input voltage and coupled inductor turn ratio. The V_{LX} voltage is calculated as follows:

$$V_{LX} = V_{INPUT} \frac{V_O}{n} \frac{V_{INPUT}}{1} \frac{V_O}{n} \frac{nV_{INPUT}}{1} \quad (3)$$

Therefore, the turn's ratio can be easily obtained as the following equations:

$$n = \frac{V_O}{V_{LX}} \frac{V_{LX}}{V_{INPUT}} \quad (4)$$

To determine the turn's ratio, the input voltage variation has to be considered as well.

The inductor parameters are directly related to the device performance, saturation current and DC resistance. The lower the DC resistance, the higher efficiency. Usually a trade-off between inductor size, cost and overall efficiency is needed to make the optimum choice.

The inductor saturation current should be rated around 2 A at maximum power in the FAN8841. If to use a low saturation current inductor under 2 A due to inductor size, it is possible using the OCP level control.

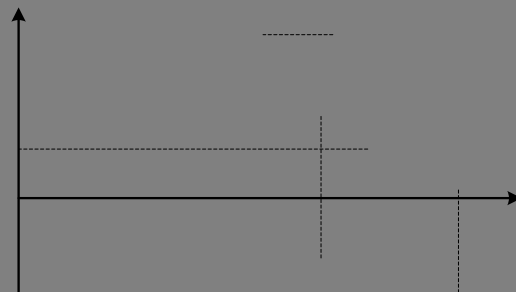


Figure 29. Current Waveform

In CRM operation, the inductance can be obtained from the slope of the inductor current, as shown in Figure 29. During FET turn off period, the inductor current flows through the diode. The diode peak current is expressed as follows:

$$I_{D,PK} = \frac{2I_{OUT}}{1 - d} \quad (5)$$

And then, the peak current of the main switch is obtained as follows:

$$I_{PK} = \frac{2I_{OUT}(1-n)}{1-d}, \text{ or } I_{PK} = \frac{V_{INPUT}}{L_1} dT_s \quad (6)$$

The inductance value obtained as follows:

$$L_1 = \frac{V_{INPUT} dT_s}{I_{PK}} = \frac{V_{INPUT} d(1-d)T_s}{2I_{OUT}(1-n)} \quad (7)$$

If a user wants a commercial inductor at output voltage under 35 V condition, n(turns ratio at using coupled inductor) should be substituted the value zero, (turns ratio at using coupled inductor).

Output Capacitor Selection

The value of the output capacitor can be selected based on the output voltage ripple requirements. Without consideration of the effect of Equivalent Series Resistance (ESR) as output capacitors, the output voltage ripple in a peak-to-peak manner is obtained as follows:

$$V_{ripple,pp} = \frac{I_{OUT} T_s}{C_o} \quad (8)$$

where $V_{ripple,pp}$ is the output voltage ripple in peak-to-peak manner. Therefore, the output capacitance can be selected with the given output voltages ripple specification as follows:

$$C_o = \frac{2d \frac{(1-d)^2}{2} I_{OUT} T_s}{2V_{ripple,pp}} \quad (9)$$

Diode Selection

The external diode used for the rectification is usually a Schottky diode. Its average forward current and reverse voltage maximum ratings should exceed the load current and the voltage at the output of the converter respectively.

A care should be taken to avoid any short circuit of V_{OUT} to GND, even with the IC disabled, since the diode can be instantly damaged by the excessive current.

▼



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.