Is Now Part of

ON Semiconductor®

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.

August 2016

FAN48617
Fixed-Output Synchronous TinyBoost® Regulator

Features

- Input Voltage Range: 2.7 V to 4.5 V
- Output Voltage: 5.0 V
- 1000 mA Max. Load Capability
- PWM Only
- Up to 97% Efficient
- Forced Pass-Through Operation via EN Pin
- Internal Synchronous Rectification
- True Load Disconnect
- Short-Circuit Protection
- External Components: 2016 (Metric) 1 µH Inductor, 0402 Case Size Input / Output Capacitors

Applications

- Class-D Audio Amplifier
- Boost for Low-Voltage Li-Ion Batteries
- Smart Phones, Tablets, Portable Devices
- RF Applications
- NFC Applications

Description

The FAN48617 is a low-power PWM only boost regulator designed to provide a minimum voltage-regulated rail from a standard single-cell Li-Ion battery and advanced battery chemistries. Even below the minimum system battery voltage, the device maintains the output voltage regulation for an output load current of 1000 mA. The combination of built-in power transistors, synchronous rectification, and low supply current suit the FAN48617 for battery-powered applications.

The FAN48617 is available in a 9-bump, 0.4 mm pitch, (1.215 x 1.215 mm) Wafer-Level Chip-Scale Package (WLCSP).

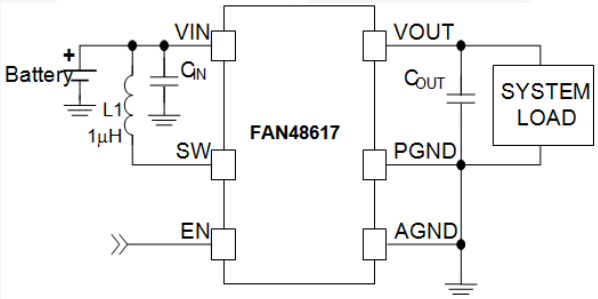


Figure 1. Typical Application

Ordering Information

Part Number	V_{OUT}	Operating Temperature	Package	Packing	Device Marking
FAN48617UC50X	5.0 V	-40°C to 85°C	9-Bump, 0.4 mm Pitch, WLCSP Package	Tape and Reel	K2

Block Diagram

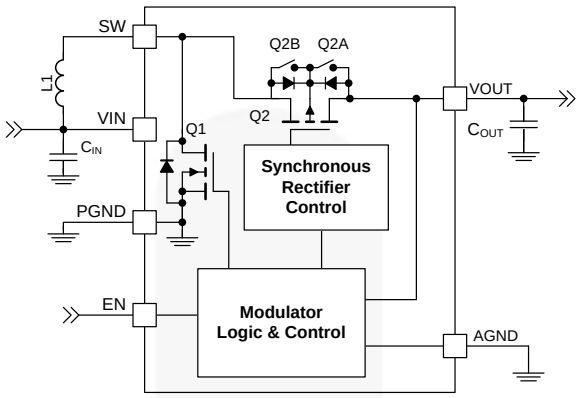


Figure 2. IC Block Diagram

Table 1. Recommended Components

Component	Description	Vendor	Parameter	Typ.	Unit
L1	20%, 3.9 A, 2016, 1.0 mm Height	DFE201610E-1R0M TOKO	Inductance	1	µH
			DCR (Series R)	48	mΩ
C_{IN}	20%, 6.3 V, X5R, 0402 (1005)	C1005X5R0J106M050BC TDK	Capacitance	10	µF
C_{OUT} 1[(1)]	20%, 6.3 V, X5R, 0402 (1005)	C1005X5R0J106M050BC TDK	Capacitance	2 x 10	
C_{OUT} 2[(2)]	20%, 6.3 V, X5R, 0402 (1005)	C1005X5R0J106M050BC TDK	Capacitance	3 x 10	

Notes:
1. For applications with I_{OUT} < 500 mA use C_{OUT} 1.
2. For applications with 500 mA ≤ I_{OUT} < 1000 mA use C_{OUT} 2.

Pin Configuration

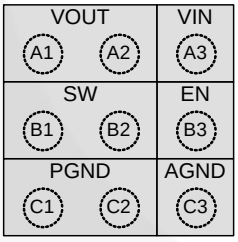


Figure 3. Top View

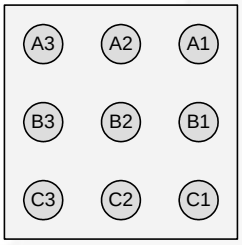


Figure 4. Bottom View

Pin Definitions

Pin #	Name	Description
A1, A2	VOUT	**Output Voltage**. This pin is the output voltage terminal; connect directly to C_{OUT}.
A3	VIN	**Input Voltage**. Connect to Li-Ion battery input power source and C_{IN}.
B1, B2	SW	**Switching Node**. Connect to inductor.
B3	EN	**Enable**. When this pin is HIGH, the circuit is enabled. After part is engaged, pin forces part into Forced-Pass-Through Mode when EN pin is pulled LOW.
C1, C2	PGND	**Power Ground**. This is the power return for the IC. C_{OUT} capacitor should be returned with the shortest path possible to these pins.
C3	AGND	**Analog Ground**. This is the signal ground reference for the IC. All voltage levels are measured with respect to this pin – connect to PGND at a single point.

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. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter		Min.	Max.	Unit
V_{IN}	Voltage on VIN Pin		-0.3	6.0	V
V_{OUT}	Voltage on VOUT Pin			6.0	V
V_{SW}	SW Node	DC	-0.3	6.0	V
		Transient: 10 ns, 3 MHz	-1.0	8.0	
V_{CC}	Voltage on Other Pins		-0.3	6.0[3]	V
ESD	Electrostatic Discharge Protection Level	Human Body Model, ANSI/ESDA/JEDEC JS-001-2012	2.0		kV
		Charged Device Model per JESD22-C101	1.0		
T_J	Junction Temperature		-40	+150	°C
T_{STG}	Storage Temperature		-65	+150	°C
T_L	Lead Soldering Temperature, 10 Seconds			+260	°C

Note:

3. Lesser of 6.0 V or V_{IN} + 0.3 V.

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

Symbol	Parameter	Min.	Max.	Unit
V_{IN}	Supply Voltage	2.7	4.5	V
I_{OUT}	Maximum Output Current	1000		mA
T_A	Ambient Temperature	-40	+85	°C
T_J	Junction Temperature	-40	+125	°C

Thermal Properties

Junction-to-ambient thermal resistance is a function of application and board layout. This data is measured with four-layer 2s2p boards with vias in accordance to JEDEC standard JESD51. Special attention must be paid not to exceed junction temperature, $T_{J(max)}$, at a given ambient temperature, T_A.

Symbol	Parameter	Typical	Unit
Θ_{JA}	Junction-to-Ambient Thermal Resistance	50	°C/W

Electrical Specifications

Recommended operating conditions, unless otherwise noted, circuit per Figure 1, V_{OUT} = 5.0 V. Typical, minimum and maximum values are given at V_{IN} = 3.6 V, T_A = 25˚C, -40°C, and +85°C.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Power Supply						
I_Q	V_{IN} Quiescent Current	I_{OUT} = 0 mA, EN = 1.8 V, No Switching		95		µA
		Forced Pass-Through EN = 0 V, $V_{OUT} = V_{IN}$		3.5		
V_{UVLO}	Under-Voltage Lockout	V_{IN} Rising		2.20		V
V_{UVLO_HYS}	Under-Voltage Lockout Hysteresis			150		mV
Inputs						
V_{IH}	Enable HIGH Voltage		1.05			V
V_{IL}	Enable LOW Voltage				0.4	V
Outputs						
V_{REG}	Output Voltage Accuracy DC[4]	2.7 V ≤ V_{IN} ≤ 4.5 V	-2		+2	%
Timing						
f_{SW}	Switching Frequency	I_{OUT} = 300 mA	1.8	2.3	2.8	MHz
t_{SS}[5]	EN HIGH to 95% of Regulation	I_{OUT} = 150 mA		425		µs
t_{RST}[5]	FAULT Restart Timer			20		ms
Power Stage						
$R_{DS(ON)N}$	N-Channel Boost Switch $R_{DS(ON)}$			63		mΩ
$R_{DS(ON)P}$	P-Channel Sync. Rectifier $R_{DS(ON)}$			52		mΩ

Notes:

4. DC I_{LOAD} from 0 to 1000 mA. V_{OUT} measured from mid-point of output voltage ripple. Effective capacitance of $C_{OUT} \geq 6.3$ µF.
5. Guaranteed by design and characterization; not tested in production.

Typical Performance Characteristics

Unless otherwise specified; V_{IN} = 3.6 V, V_{OUT} = 5.0 V, T_A = 25°C, and circuit according to Figure 1.
Components: C_{IN} = 10 µF, C_{OUT} = 3 x 10 µF (0402, X5R, 6.3 V, C1005X5R0J106M050BC), L1 = 1 µH (2016, 48 mΩ, DFE201610E-1R0M).

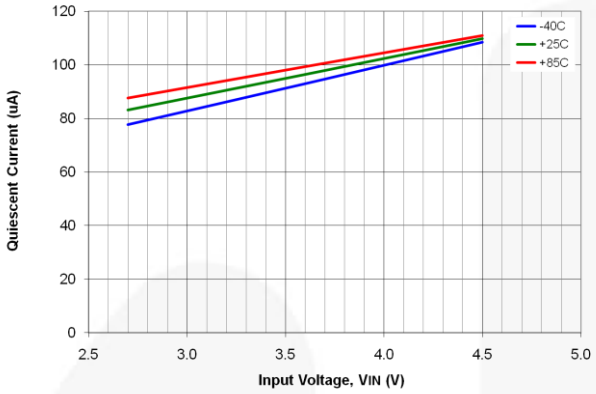


Figure 5. Quiescent Current (No Switching) vs. Input Voltage and Temperature

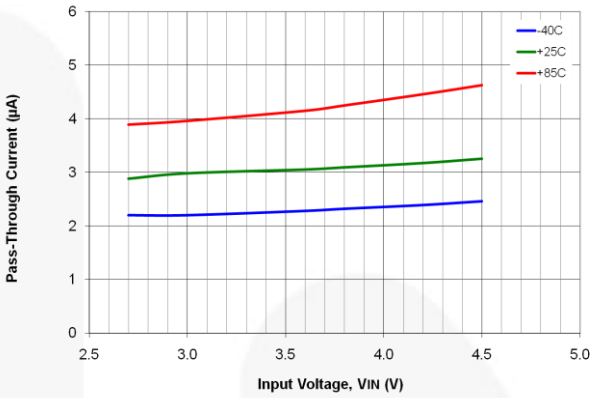


Figure 6. Pass-Through Current vs. Input Voltage and Temperature

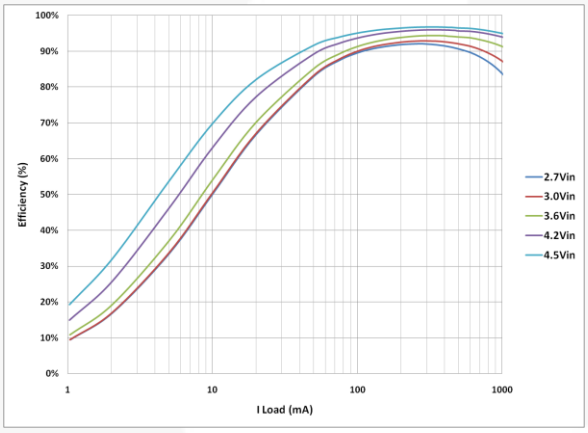


Figure 7. Efficiency vs. Load Current and Input Voltage

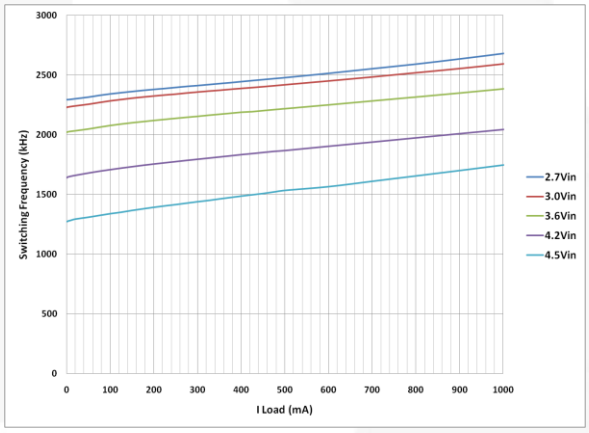


Figure 8. Switching Frequency vs. Load Current and Input Voltage

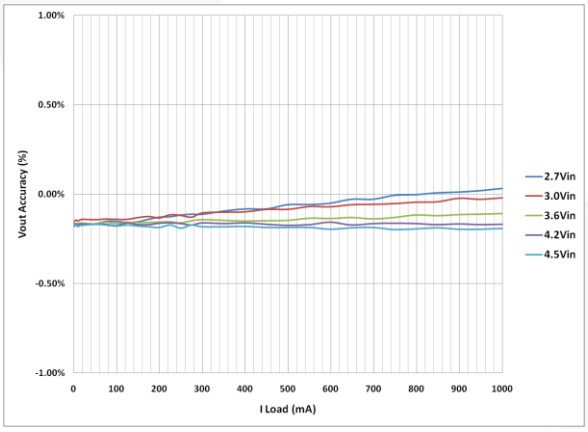


Figure 9. Output Regulation vs. Load Current and Input Voltage

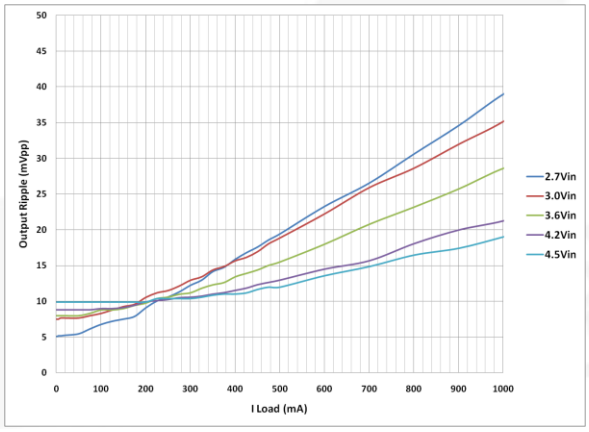


Figure 10. Output Ripple vs. Load Current and Input Voltage

Typical Performance Characteristics

Unless otherwise specified; V_{IN} = 3.6 V, V_{OUT} = 5.0 V, T_A = 25°C, and circuit and components according to Figure 1. Components: C_{IN} = 10 µF, C_{OUT} = 3 x 10 µF (0402, X5R, 6.3 V, C1005X5R0J106M050BC), L1 = 1 µH (2016, 48 mΩ, DFE201610E-1R0M).

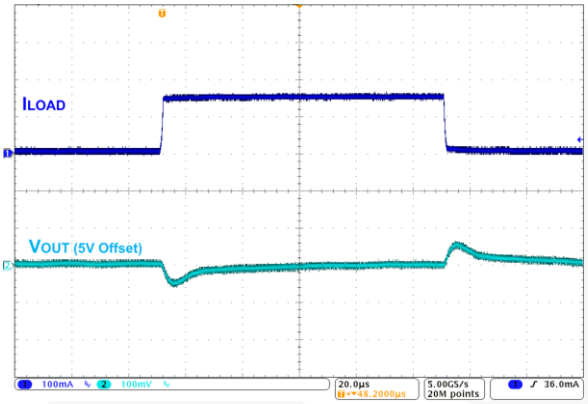


Figure 11. Load Transient, 10 <-->150 mA, 1 µs Edge

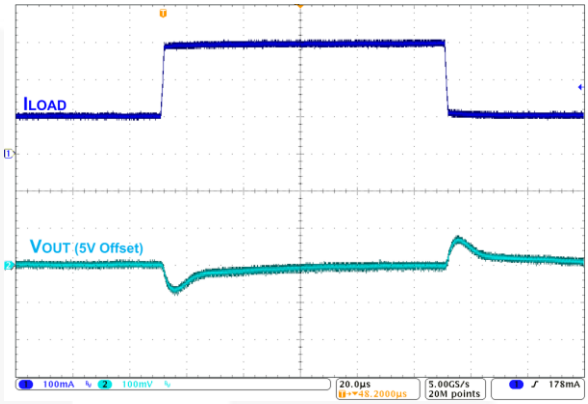


Figure 12. Load Transient, 100 <--> 300 mA, 1 µs Edge

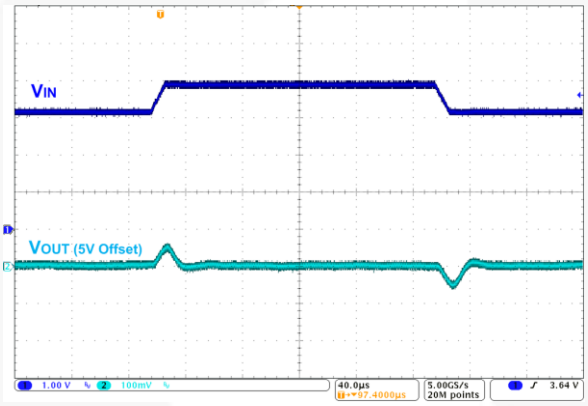


Figure 13. Line Transient, 3.2 V <-->3.9 V, 10 µs Edge, 150 mA Load

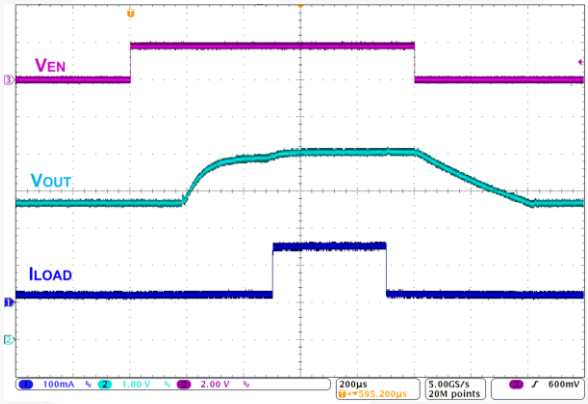


Figure 14. Pass-Through Mode <--> Boost Mode with Load Transient, 20 <-->150 mA, 1 µs Edge

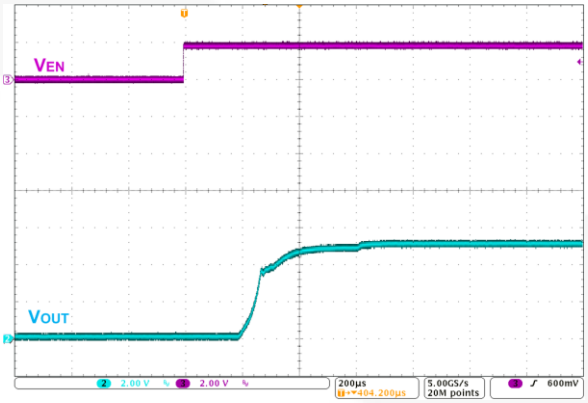


Figure 15. Startup, 150 mA Load

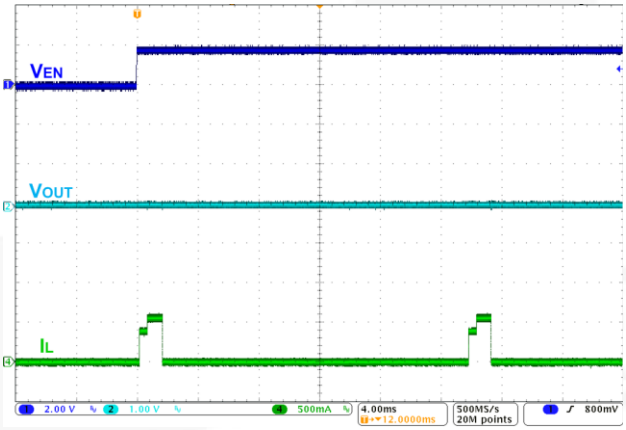


Figure 16. Fault Restart

Circuit Description

FAN48617 is a synchronous PWM Only boost regulator. The regulator's Pass-Through Mode automatically activates when V_{IN} is above the boost regulator's set point.

Table 2. Operating Modes

Mode	Description	Invoked When:
LIN	Linear Startup	$V_{IN} > V_{OUT}$
SS	Boost Soft-Start	$V_{IN} < V_{OUT} < V_{OUT(TARGET)}$
BST	Boost Operating Mode	$V_{OUT} = V_{OUT(TARGET)}$
PT	Pass-Through Mode	$V_{IN} > V_{OUT(TARGET)}$ or when EN is pulled LOW after initial startup

Boost Mode Regulation

The FAN48617 uses a current-mode modulator to achieve excellent transient response.

Table 3. Boost Startup Sequence

Start Mode	Entry	Exit	End Mode	Timeout (µs)
LIN1	$V_{IN} > V_{UVLO}$, EN=1	$V_{OUT} > V_{IN}$-300 mV	SS	
		Timeout	LIN2	512
LIN2	LIN1 Exit	$V_{OUT} > V_{IN}$-300 mV	SS	
		Timeout	FAULT	1024
SS	LIN1 or LIN2 Exit	$V_{OUT}=V_{OUT(TARGET)}$	BST	
		Overload Timeout	FAULT	64

LIN Mode

When EN is HIGH and $V_{IN} > V_{UVLO}$, the regulator first attempts to bring V_{OUT} within 300 mV of V_{IN} by using the internal fixed-current source from VIN (Q2). The current is limited to the LIN1 set point.

If V_{OUT} reaches V_{IN}-300 mV during LIN1 Mode, the SS Mode is initiated. Otherwise, LIN1 times out after 512 µs and LIN2 Mode is entered.

In LIN2 Mode, the current source is incremented. If V_{OUT} fails to reach V_{IN}-300 mV after 1024 µs, a fault condition is declared and the device waits 20 ms to attempt an automatic restart.

Soft-Start (SS) Mode

Upon the successful completion of LIN Mode ($V_{OUT} \geq V_{IN}$-300 mV), the regulator begins switching with boost pulses current limited to 50% of nominal level.

During SS Mode, if V_{OUT} fails to reach regulation during the SS ramp sequence for more than 64 µs, a fault is declared. If large C_{OUT} is used, the reference is automatically stepped slower to avoid excessive input current draw.

Boost (BST) Mode

This is a normal operating mode of the regulator.

Pass-Through (PT) Mode

The device allows the user to force the device in Forced Pass-Through Mode through the EN pin. If the EN pin is pulled HIGH, the device starts operating in Boost Mode. Once the EN pin is pulled LOW, the device is forced into Pass-Through Mode. To disable the device, the input supply voltage must be removed. The device cannot startup in Forced Pass-Through Mode *(see Figure 17)*. During startup, keep the EN pulled HIGH for at least 350 µs before pulling it LOW in order to make sure that the device enters Pass-Through Mode realiably

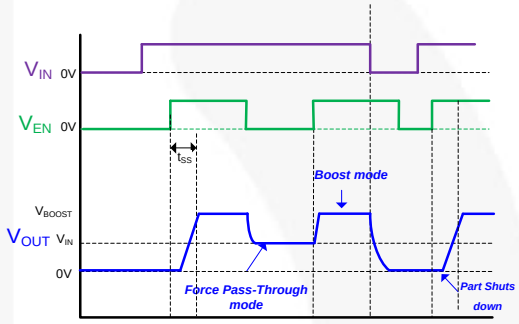


Figure 17. Pass-Through Profile

Current Limit Protection

The FAN48617 has valley current limit protection in case of overload situations. The valley current limit will prevent high current from causing damage to the IC and the inductor. The current limit is halved during soft-start.

When starting into a fault condition, the input current will be limited by LIN1 and LIN2 current threshold.

Fault State

The regulator enters Fault State under any of the following conditions:

- V_{OUT} fails to achieve the voltage required to advance from LIN Mode to SS Mode.
- V_{OUT} fails to achieve the voltage required to advance from SS Mode to BST Mode.
- Boost current limit triggers for 2 ms during BST Mode.
- $V_{IN} - V_{OUT} > 300$ mV; this fault can occur only after successful completion of the soft-start sequence.
- $V_{IN} < V_{UVLO}$.

Once a fault is triggered, the regulator stops switching and presents a high-impedance path between VIN and VOUT. After waiting 20 ms, an automatic restart is attempted.

Over-Temperature

The regulator shuts down if the die temperature exceeds 150°C and restarts when the IC cools by ~20°C.

Application Information

Output Capacitance (C_{OUT})

The effective capacitance (C_{EFF}[6]) of small, high-value ceramic capacitors decreases as their bias voltage increases, as illustrated in the graph below:

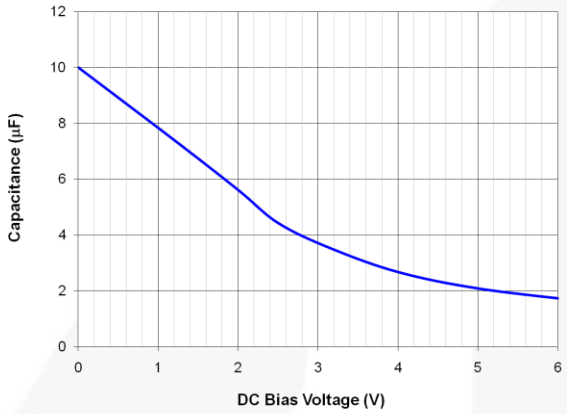


Figure 18. C_{EFF} for 10 µF, 0402, X5R, 6.3 V-Rated Capacitor (TDK C1005X5R0J106M050BC)

FAN48617 is guaranteed for stable operation with the minimum value of C_{EFF} ($C_{EFF(MIN)}$) outlined in Table 4.

Table 4. Minimum C_{EFF} Required for Stability

Operating Conditions			$C_{EFF(MIN)}$ (µF)
V_{OUT} (V)	V_{IN} (V)	I_{LOAD} (mA)	
5.0	2.7 to 4.5	0 to 500	4.2
5.0	2.7 to 4.5	0 to 1000	6.3

Note:

6. C_{EFF} varies by manufacturer, capacitor material, and case size.

Layout Recommendations

The layout recommendations below highlight various top-copper pours by using different colors.

To minimize spikes at VOUT, C_{OUT} must be placed as close as possible to PGND and VOUT, as shown in Figure 19.

For best thermal performance, maximize the pour area for all planes other than SW. The ground pour, especially, should fill all available PCB surface area and be tied to internal layers with a cluster of thermal vias.

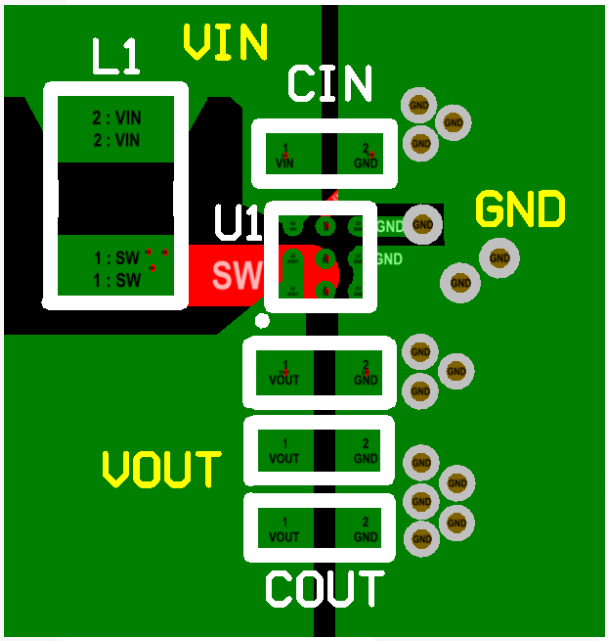
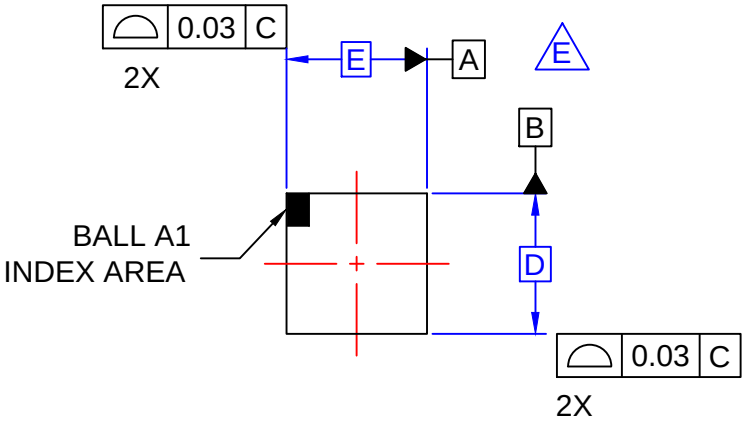


Figure 19. Layout Recommendation

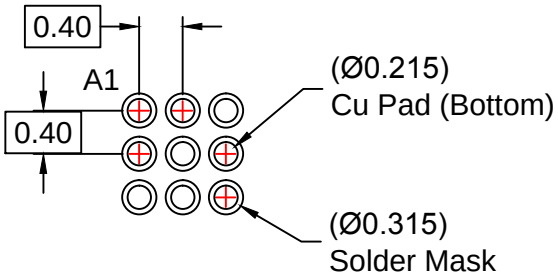
The table below pertains to MOD drawing on the following page.

Product-Specific Package Dimensions

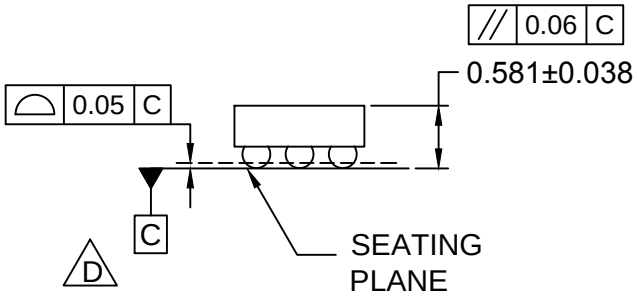
Product	D	E	X	Y
FAN48617UC50X	1.215 ±0.030 mm	1.215 ±0.030 mm	0.2075 mm	0.2075 mm

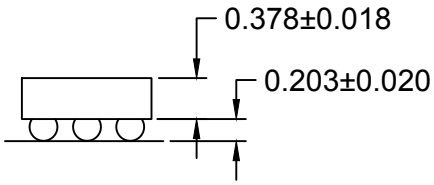


TOP VIEW

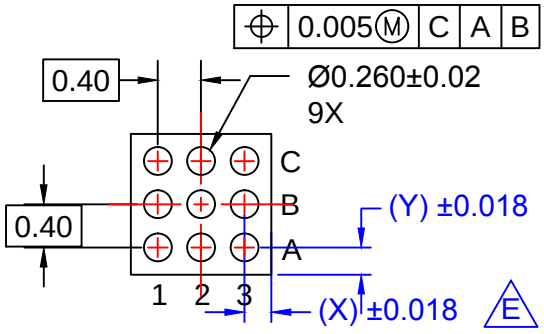


RECOMMENDED LAND PATTERN
(NSMD PAD TYPE)





SIDE VIEWS



BOTTOM VIEW

NOTES

A. NO JEDEC REGISTRATION APPLIES.
B. DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS AND TOLERANCE PER ASME Y14.5M, 2009.
D. DATUM C IS DEFINED BY THE SPHERICAL CROWNS OF THE BALLS.
E. FOR DIMENSIONS D,E,X, AND Y SEE PRODUCT DATASHEET.
F. DRAWING FILNAME: MKT-UC009Ak rev3

ON Semiconductor

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

X-ON Electronics

Largest Supplier of Electrical and Electronic Components

Click to view similar products for Switching Voltage Regulators ***category:***

Click to view products by ON Semiconductor ***manufacturer:***

Other Similar products are found below :

FAN53610AUC33X FAN53611AUC123X FAN48610BUC33X FAN48610BUC45X FAN48617UC50X R3 430464BB KE177614 MAX809TTR NCV891234MW50R2G NCP81103MNTXG NCP81203PMNTXG NCP81208MNTXG NCP81109GMNTXG SCY1751FCCT1G NCP81109JMNTXG AP3409ADNTR-G1 NCP81241MNTXG LTM8064IY LT8315EFE#TRPBF NCV1077CSTBT3G XCL207A123CR-G MPM54304GMN-0002 MPM54304GMN-0003 XDPE132G5CG000XUMA1 MP8757GL-P MIC23356YFT-TR LD8116CGL HG2269M/TR OB2269 XD3526 U6215A U6215B U6620S LTC3803ES6#TR LTC3803ES6#TRM LTC3412IFE LT1425IS MAX25203BATJA/VY+ MAX77874CEWM+ XC9236D08CER-G ISL95338IRTZ MP3416GJ-P BD9S201NUX-CE2 MP5461GC-Z MPQ4415AGQB-Z MPQ4590GS-Z MCP1603-330IMC MCP1642B-18IMC MCP1642D-ADJIMC