

# Fixed-Output Synchronous TINYBOOST® Regulator

## FAN48619



WLCSP9  
CASE 567QW

### Description

The FAN48619 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 FAN48619 for battery-powered applications.

The FAN48619 is available in a 9-bump, 0.4 mm pitch, (1.215 × 1.215 mm) Wafer-Level Chip-Scale Package (WLCSP).

### 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
- Three External Components: 2016 (Metric) 0.47 μH Inductor, 0402 Case Size Input / Output Capacitors
- This is a Pb-Free and Halide Free Device

### Applications

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

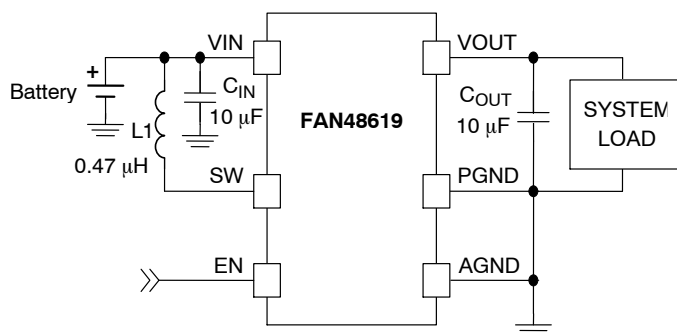
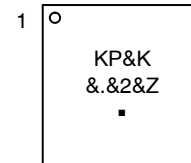


Figure 1. Typical Application

### MARKING DIAGRAM



|    |  |
|----|--|
| KP | = Specific Device Code                 |
| &K | = 2-Digit Lot Run Code                 |
| &. | = Pin One Dot                          |
| &2 | = 2-Digit Date Code<br>(Year and Week) |
| &Z | = Assembly Plant Code                  |
| ▪  | = Pb-Free Package                      |

(Note: Microdot may be in either location)

### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

# FAN48619

## BLOCK DIAGRAMS

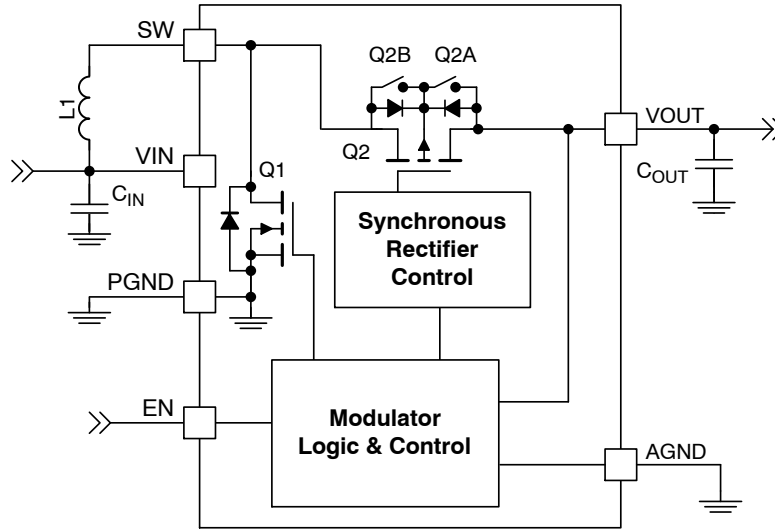


Figure 2. IC Block Diagram

Table 1. RECOMMENDED COMPONENTS

| Component        | Description                     | Vendor                     | Parameter      | Typical Value | Unit |
|------------------|---------------------------------|----------------------------|----------------|---------------|------|
| L1               | 20%, 5.3 A, 2016, 1.0 mm Height | DFE201610E-R47M<br>TOKO    | Inductance     | 470           | nH   |
|                  |                                 |                            | DCR (Series R) | 26            | mΩ   |
| C <sub>IN</sub>  | 20%, 6.3 V, X5R, 0402 (1005)    | C1005X5R0J106M050BC<br>TDK | Capacitance    | 10            | μF   |
| C <sub>OUT</sub> | 20%, 6.3 V, X5R, 0402 (1005)    | C1005X5R0J106M050BC<br>TDK | Capacitance    | 10            |      |

## ORDERING INFORMATION

| Part Number               | V <sub>OUT</sub> | Device Marking | Operating Temperature Range | Package                                | Packing Method†    |
|---------------------------|------------------|----------------|-----------------------------|--|--------------------|
| FAN48619UC50X<br>(Note 1) | 5.0 V            | KP             | -40°C to 85°C               | 9-Bump, 0.4 mm Pitch,<br>WLCSP Package | 3000 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, [BRD8011/D](#).

1. The FAN48619UC50X includes backside lamination.

PIN CONFIGURATION

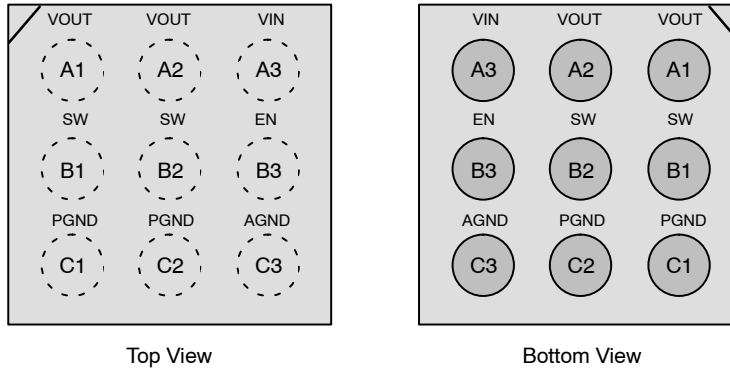


Figure 3. Pin Assignment

Table 2. PIN DEFINITIONS

| Pin #  | Name | Description   |
|--------|------|---|
| A1, A2 | VOUT | <b>Output Voltage:</b> This pin is the output voltage terminal. Connect directly to C <sub>OUT</sub> .  |
| A3     | VIN  | <b>Input Voltage:</b> Connect to Li-Ion battery input power source and C <sub>IN</sub> .  |
| B1, B2 | SW   | <b>Switching Node:</b> Connect to inductor.   |
| B3     | EN   | <b>Enable:</b> 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 | <b>Power Ground:</b> This is the power return for the IC. C <sub>OUT</sub> capacitor should be returned with the shortest path possible to these pins.              |
| C3     | AGND | <b>Analog Ground:</b> 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. |

**Table 3. ABSOLUTE MAXIMUM RATINGS**

| Symbol           | Parameter                                |   | Min  | Max             | Unit |
|------------------|--|---|------|-----------------|------|
| V <sub>IN</sub>  | Voltage on VIN Pin                       |   | -0.3 | 6.0             | V    |
| V <sub>OUT</sub> | Voltage on VOUT Pin                      |   | -0.3 | 6.0             | V    |
| V <sub>SW</sub>  | SW Node                                  | DC  | -0.3 | 6.0             | V    |
|                  |  | Transient: 10 ns, 3 MHz                       | -1.0 | 8.0             |      |
| V <sub>CC</sub>  | Voltage on Other Pins                    |   | -0.3 | 6.0<br>(Note 2) | 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 <sub>J</sub>   | Junction Temperature                     |   | -40  | 150             | °C   |
| T <sub>STG</sub> | Storage Temperature                      |   | -65  | 150             | °C   |
| T <sub>L</sub>   | Lead Soldering Temperature, 10 Seconds   |   | -    | 260             | °C   |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

2. Lesser of 6.0 V or V<sub>IN</sub> + 0.3 V.

**Table 4. RECOMMENDED OPERATING CONDITIONS**

| Symbol           | Parameter              | Min  | Max  | Unit |
|------------------|------------------------|------|------|------|
| V <sub>IN</sub>  | Supply Voltage         | 2.7  | 4.5  | V    |
| I <sub>OUT</sub> | Maximum Output Current | 1000 | -    | mA   |
| T <sub>A</sub>   | Ambient Temperature    | -40  | +85  | °C   |
| T <sub>J</sub>   | Junction Temperature   | -40  | +125 | °C   |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

**Table 5. THERMAL PROPERTIES**

| Symbol          | Parameter                              | Typical | Unit |
|-----------------|--|---------|------|
| θ <sub>JA</sub> | Junction-to-Ambient Thermal Resistance | 101     | °C/W |

NOTE: 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<sub>J(max)</sub>, at a given ambient temperature, T<sub>A</sub>.

**Table 6. ELECTRICAL SPECIFICATIONS**

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

| Symbol              | Parameter                              | Conditions   | Min  | Typ  | Max | Unit             |
|---------------------|--|--|------|------|-----|------------------|
| <b>POWER SUPPLY</b> |  |  |      |      |     |                  |
| $I_Q$               | $V_{IN}$ Quiescent Current             | $I_{OUT} = 0\text{ mA}$ , EN = 1.8 V, No Switching | –    | 95   | –   | $\mu\text{A}$    |
|                     |  | 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               |
| <b>INPUTS</b>       |  |  |      |      |     |                  |
| $V_{IH}$            | Enable HIGH Voltage                    |  | 1.05 | –    | –   | V                |
| $V_{IL}$            | Enable LOW Voltage                     |  | –    | –    | 0.4 | V                |
| <b>OUTPUTS</b>      |  |  |      |      |     |                  |
| $V_{REG}$           | Output Voltage Accuracy DC (Note 3)    | $2.7\text{ V} \leq V_{IN} \leq 4.5\text{ V}$       | –2   | –    | +2  | %                |
| <b>TIMING</b>       |  |  |      |      |     |                  |
| $f_{SW}$            | Switching Frequency                    | $I_{OUT} = 300\text{ mA}$                          | 1.8  | 2.3  | 2.8 | MHz              |
| $t_{SS}$ (Note 4)   | EN HIGH to 95% of Regulation           | $I_{OUT} = 150\text{ mA}$                          | –    | 425  | –   | $\mu\text{s}$    |
| $t_{RST}$ (Note 4)  | FAULT Restart Timer                    |  | –    | 20   | –   | ms               |
| <b>POWER STAGE</b>  |  |  |      |      |     |                  |
| $R_{DS(ON)N}$       | N-Channel Boost Switch $R_{DS(ON)}$    |  | –    | 63   | –   | $\text{m}\Omega$ |
| $R_{DS(ON)P}$       | P-Channel Sync. Rectifier $R_{DS(ON)}$ |  | –    | 52   | –   | $\text{m}\Omega$ |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. DC  $I_{LOAD}$  from 0 to 1000 mA.  $V_{OUT}$  measured from mid-point of output voltage ripple. Effective capacitance of  $C_{OUT} \geq 2\ \mu\text{F}$ .

4. Guaranteed by design and characterization; not tested in production.

TYPICAL PERFORMANCE CHARACTERISTICS

Unless otherwise specified;  $V_{IN} = 3.6\text{ V}$ ,  $V_{OUT} = 5.0\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , and circuit according to Figure 1. Components:  $C_{IN} = C_{OUT} = 10\ \mu\text{F}$  (0402, X5R, 6.3 V,

C1005X5R0J106M050BC),  $L1 = 470\text{ nH}$  (2016, 26 m $\Omega$ , DFE201610E-R47M).

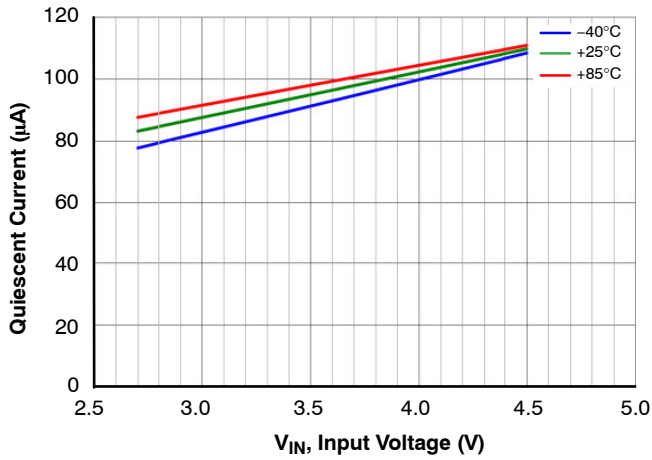


Figure 4. Quiescent Current (No Switching) vs. Input Voltage and Temperature

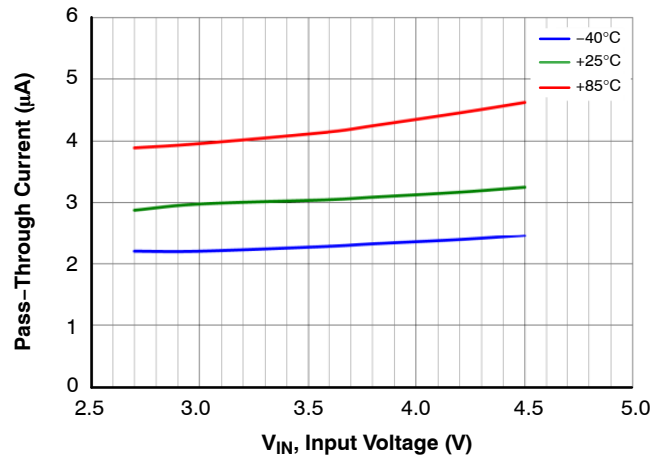


Figure 5. Pass-Through Current vs. Input Voltage and Temperature

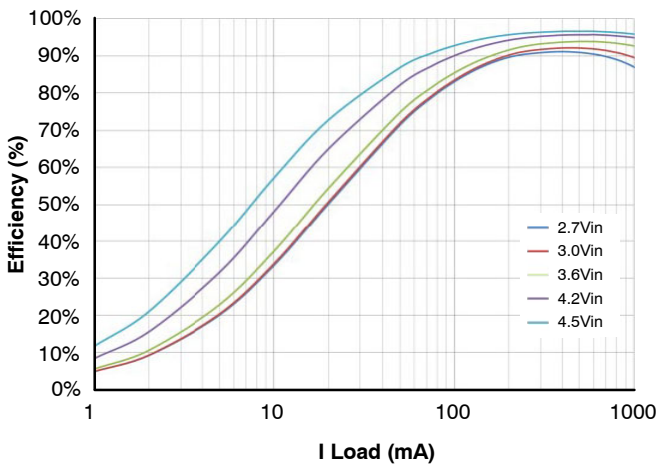


Figure 6. Efficiency vs. Load Current and Input Voltage

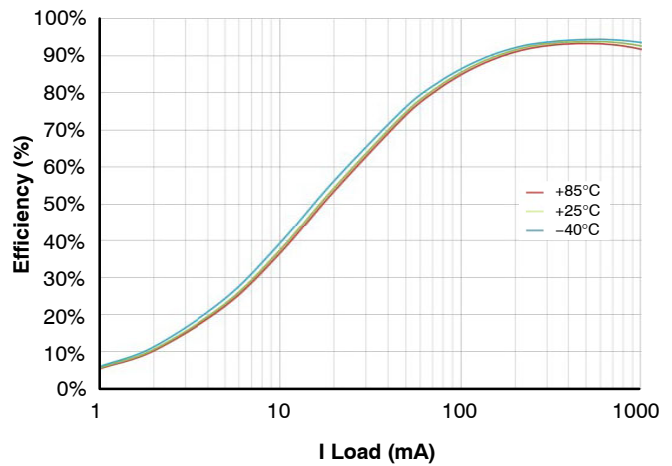


Figure 7. Efficiency vs. Load Current and Temperature

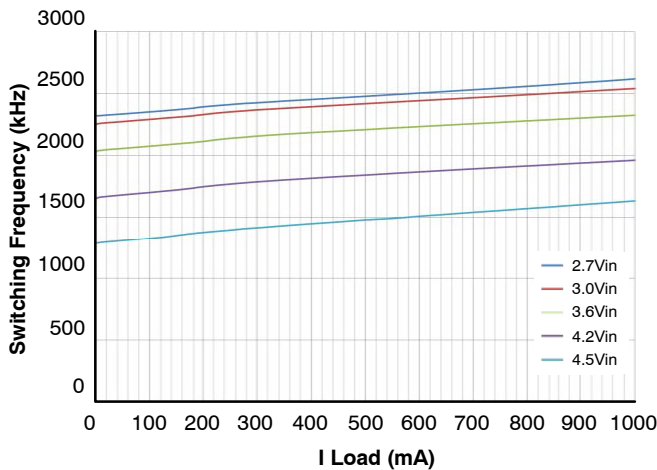


Figure 8. Switching Frequency vs. Load Current and Input Voltage

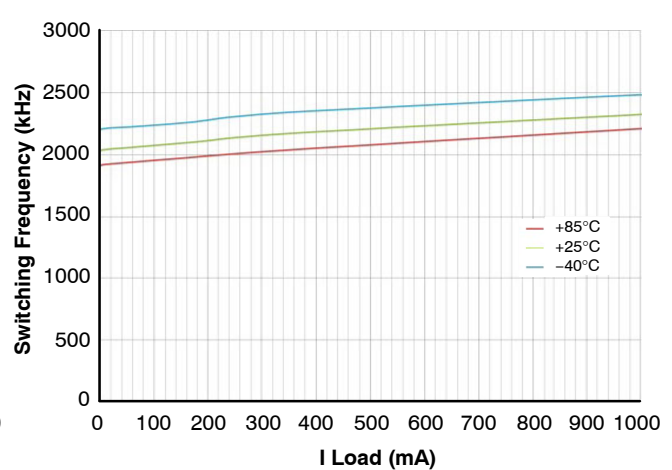


Figure 9. Switching Frequency vs. Load Current and Temperature

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Unless otherwise specified;  $V_{IN} = 3.6\text{ V}$ ,  $V_{OUT} = 5.0\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , and circuit and components according to Figure 1.

Components:  $C_{IN} = C_{OUT} = 10\ \mu\text{F}$  (0402, X5R, 6.3 V, C1005X5R0J106M050BC),  $L1 = 470\text{ nH}$  (2016, 26 m $\Omega$ , DFE201610E-R47M).

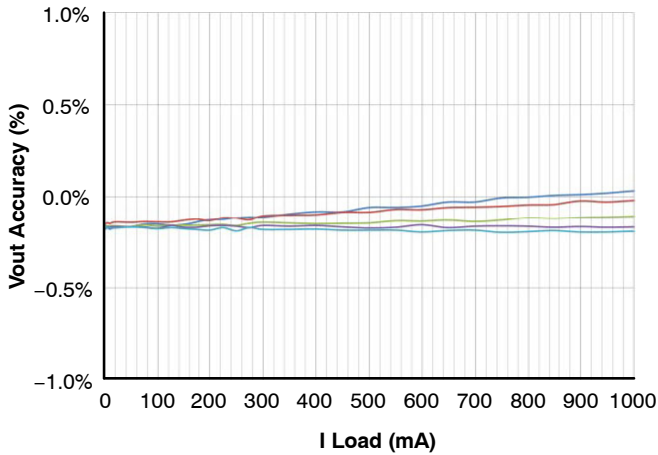


Figure 10. Output Regulation vs. Load Current and Input Voltage

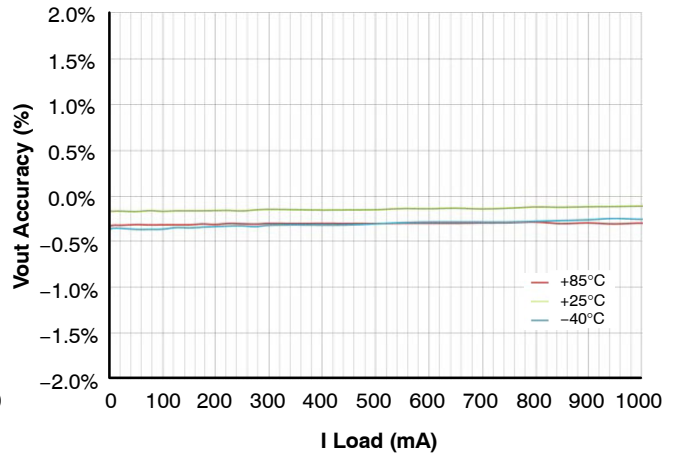


Figure 11. Output Regulation vs. Load Current and Temperature

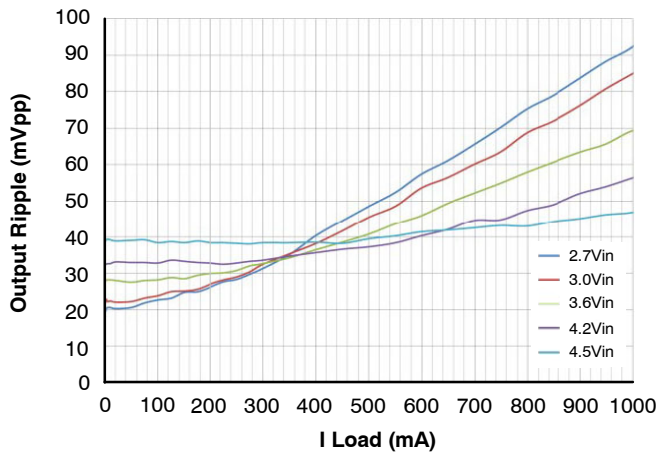


Figure 12. Output Ripple vs. Load Current and Input Voltage

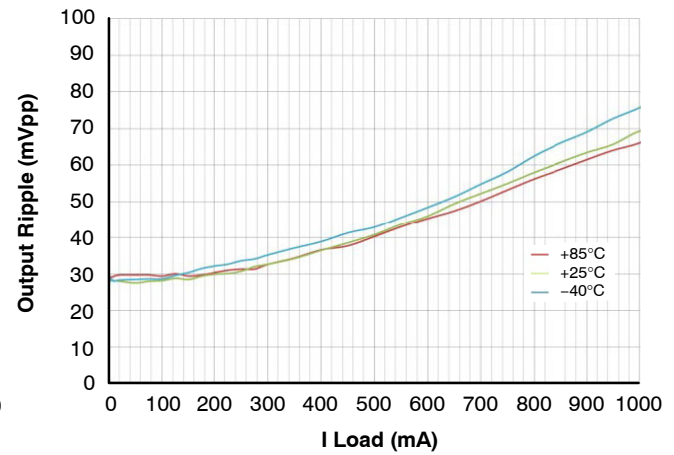


Figure 13. Output Ripple vs. Load Current and Temperature

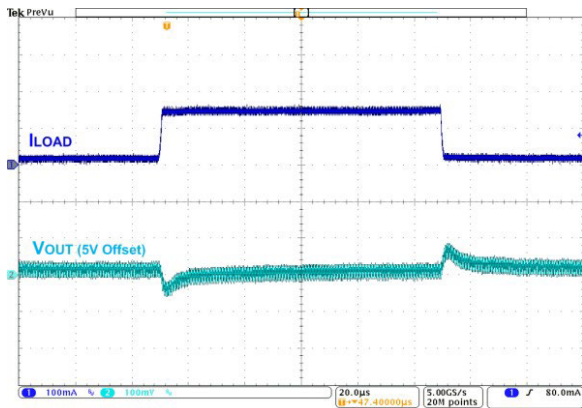


Figure 14. Load Transient, 20 <--> 150 mA, 1  $\mu\text{s}$  Edge

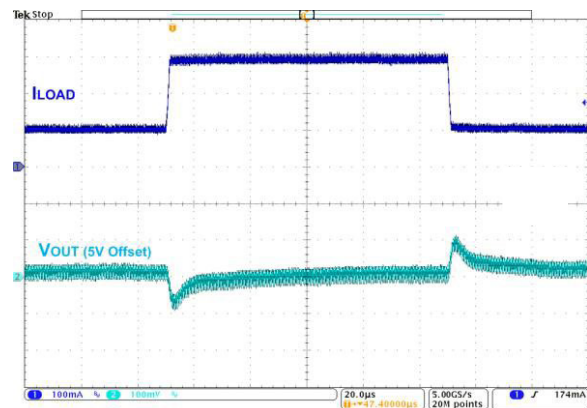


Figure 15. Load Transient, 100 <--> 300 mA, 1  $\mu\text{s}$  Edge

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Unless otherwise specified;  $V_{IN} = 3.6\text{ V}$ ,  $V_{OUT} = 5.0\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , and circuit and components according to Figure 1.

Components:  $C_{IN} = C_{OUT} = 10\ \mu\text{F}$  (0402, X5R, 6.3 V, C1005X5R0J106M050BC),  $L_1 = 470\ \text{nH}$  (2016, 26  $\text{m}\Omega$ , DFE201610E-R47M).

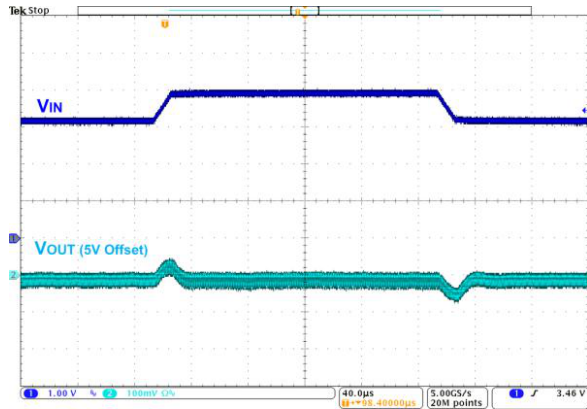


Figure 16. Line Transient, 3.2 V  $\leftrightarrow$  3.9 V, 10  $\mu\text{s}$  Edge, 150 mA Load

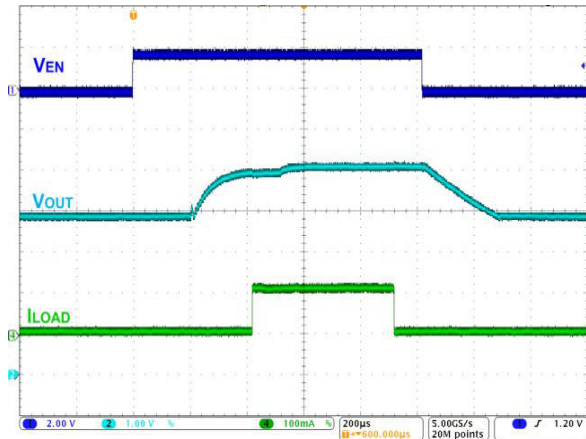


Figure 17. Pass-Through Mode  $\leftrightarrow$  Boost Mode with Load Transient, 10  $\leftrightarrow$  150 mA, 1  $\mu\text{s}$  Edge

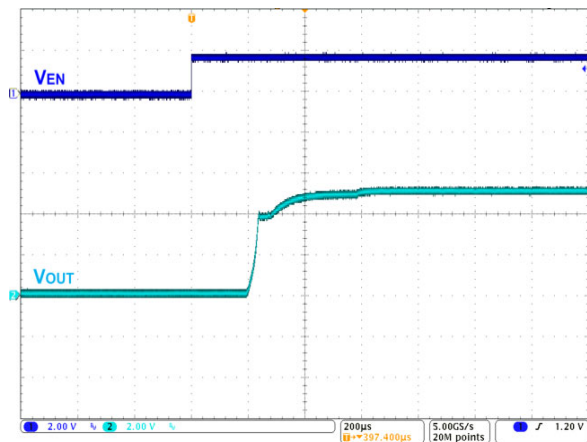


Figure 18. Startup, 150 mA Load

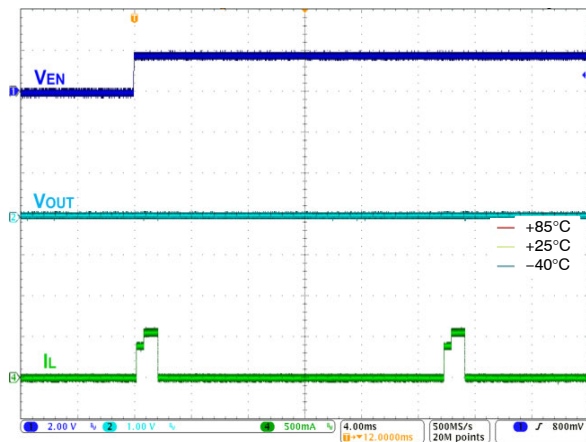


Figure 19. Fault Restart

**Circuit Description**

FAN48619 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 7. 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 FAN48619 uses a current-mode modulator to achieve excellent transient response.

**Table 8. BOOST STARTUP SEQUENCE**

| Start Mode | Entry                     | Exit                             | End Mode | Timeout (μs) |
|------------|---------------------------|----------------------------------|----------|--------------|
| LIN1       | $V_{IN} > V_{UVLO}, EN=1$ | $V_{OUT} > V_{IN}-300\text{ mV}$ | SS       | -            |
|            |                           | Timeout                          | LIN2     | 512          |
| LIN2       | LIN1 Exit                 | $V_{OUT} > V_{IN}-300\text{ mV}$ | 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  $V_{IN}-300\text{ mV}$  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  $V_{IN}-300\text{ mV}$  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 ( $V_{OUT} > V_{IN}-300\text{ mV}$ ), the regulator begins switching with boost pulses current limited to 50% of nominal level.

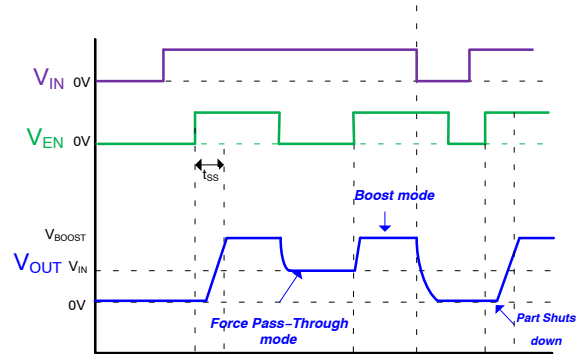
During SS Mode, if  $V_{OUT}$  fails to reach regulation during the SS ramp sequence for more than 64 μs, a fault is declared. If large  $C_{OUT}$  is used, the reference is automatically stepped slower to avoid excessive input current draw.

**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 20). 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 reliably.



**Figure 20. Pass-Through Profile**

**Current Limit Protection**

The FAN48619 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.
- $V_{IN} - V_{OUT} > 300\text{ mV}$ ; 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.

**Layout Recommendations**

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

To minimize spikes at VOUT, COUT must be placed as close as possible to PGND and VOUT, as shown in Figure 21.

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.

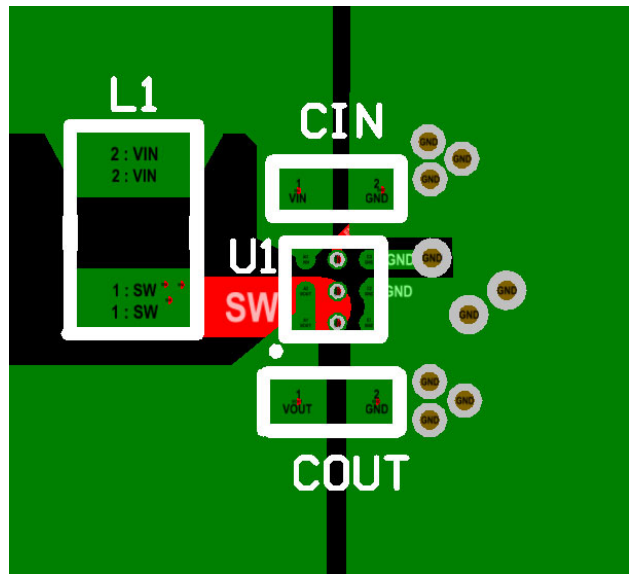
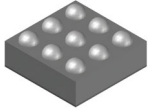
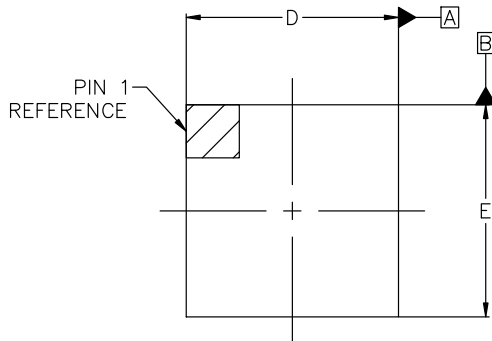


Figure 21. Layout Recommendation

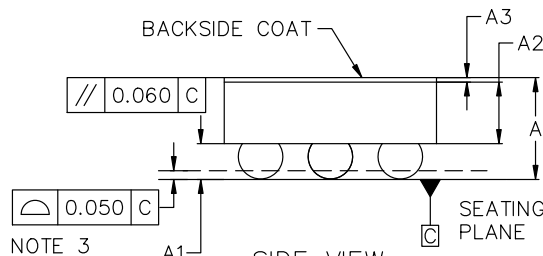


**WLCSP-9 1.22x1.22x0.38, 0.40P**  
**CASE 567QW**  
**ISSUE C**

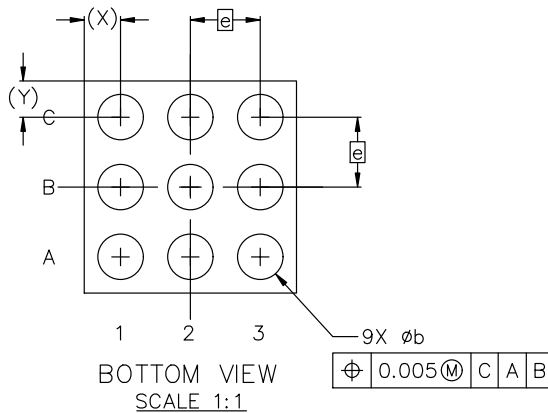
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TOP VIEW  
SCALE 1:1



SIDE VIEW  
SCALE 1:1

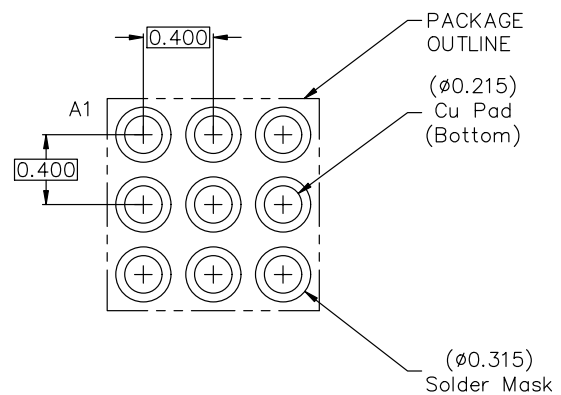


BOTTOM VIEW  
SCALE 1:1

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. COPLANARITY APPLIES TO THE SPHERICAL CROWNS OF THE SOLDER BALLS.
4. DATUM C, THE SEATING PLANE, IS DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
5. DIMENSION b IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER PARALLEL TO DATUM C.

| DIM | MILLIMETERS |       |       |
|-----|-------------|-------|-------|
|     | MIN.        | NOM.  | MAX.  |
| A   | 0.542       | 0.581 | 0.620 |
| A1  | 0.183       | 0.203 | 0.223 |
| A2  | 0.335       | 0.353 | 0.371 |
| A3  | 0.022       | 0.025 | 0.027 |
| b   | 0.240       | 0.260 | 0.280 |
| D   | 1.185       | 1.215 | 1.245 |
| E   | 1.185       | 1.215 | 1.245 |
| e   | 0.400 BSC   |       |       |
| X   | 0.208 REF.  |       |       |
| Y   | 0.208 REF.  |       |       |



RECOMMENDED MOUNTING FOOTPRINT

\*FOR ADDITIONAL INFORMATION ON OUR Pb-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ONSEMI SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.

|                         |                                      |  |
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