



Is Now Part of



**ON Semiconductor®**

To learn more about ON Semiconductor, please visit our website at  
[www.onsemi.com](http://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](http://www.onsemi.com). Please email any questions regarding the system integration to [Fairchild\\_questions@onsemi.com](mailto:Fairchild_questions@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](http://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.



# FAN48632

## 2.5 MHz, 2.0 A Pulsed-Load Synchronous TinyBoost™ Regulator with Bypass Mode for GSM PA Supply

### Features

- Few External Components: 0.47  $\mu$ H Inductor and 0603 Case Size Input and Output Capacitors
- Input Voltage Range: 2.35 V to 5.5 V
- Fixed Output Voltage : 3.3 V, 3.5 V
- Maximum Continuous Load Current of: 1.5 A at  $V_{IN}$  of 2.6 V
- Maximum Pulsed Load current :of 2.0 A for GSM 217 Hz repetition rate ,boosting  $V_{OUT}$  to 3.3 V or 3.5 V
- Up to 96% Efficient
- True Bypass Operation when  $V_{IN} > \text{Target } V_{OUT}$
- Internal Synchronous Rectifier
- Soft-Start with True Load Disconnect
- Forced Bypass Mode
- $V_{SEL}$  Control to Optimize Target  $V_{OUT}$
- Short-Circuit Protection
- Low Operating Quiescent Current
- 16-Bump, 0.4 mm Pitch WLCSP

### Applications

- Boost for Low-Voltage Li-ion Batteries, Brownout Prevention, Supply GSM RF PA.
- Cell Phones, Smart Phones, Tablets

### Description

The FAN48632 allows systems to take advantage of new battery chemistries that can supply significant energy when the battery voltage is lower than the required voltage for system power ICs. By combining built-in power transistors, synchronous rectification, and low supply current; this IC provides a compact solution for systems using advanced Li-Ion battery chemistries.

The FAN48632 is a boost regulator designed to provide a minimum output voltage ( $V_{OUT(MIN)}$ ) from a single-cell Li-Ion battery, even when the battery voltage is below system minimum. In boost mode, output voltage regulation is guaranteed to a maximum load current of 1.5 A continuous and 2.0 A pulsed. Quiescent current in Shutdown Mode is less than 3  $\mu$ A, which maximizes battery life. The regulator transitions smoothly between Bypass and normal Boost Mode. The device can be forced into Bypass Mode to reduce quiescent current.

The FAN48632 is available in a 16-bump, 0.4 mm pitch, Wafer-Level Chip-Scale Package (WLCSP).

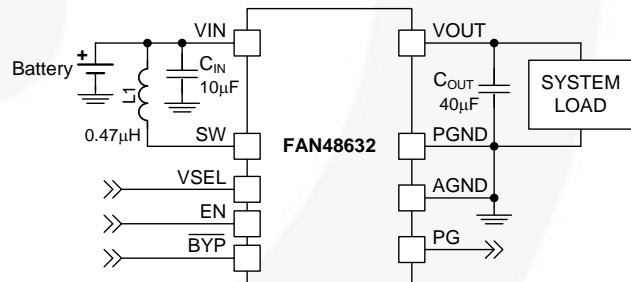


Figure 1. Typical Application

### Ordering Information

Part Number	Output Voltage $V_{SEL0} / V_{SEL1}$	Soft-Start	Forced Bypass	Operating Temperature	Package	Packing
FAN48632UC33X	3.30 / 3.49	FAST	Low $I_Q$	-40°C to 85°C	16-Ball, 4x4 Array, 0.4 mm Pitch, 250 $\mu$ m Ball, Wafer-Level Chip-Scale Package (WLCSP)	Tape and Reel
FAN48632BUC33X <sup>(1)</sup>	3.30 / 3.49	FAST	Low $I_Q$			
FAN48632UC35X	3.50 / 3.70	FAST	Low $I_Q$			

#### Note:

1. The FAN48632BUC33X includes backside lamination.

## Typical Application

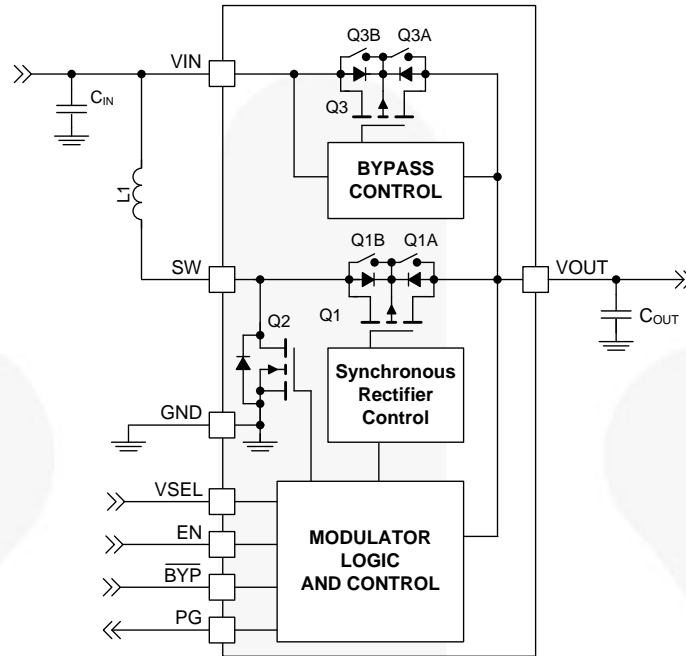


Figure 2. Block Diagram

Table 1. Recommended Components

Component	Description	Vendor	Parameter	Typ.	Unit
L1	0.47 $\mu$ H, 30%	Toko: DFE201612C DFR201612C Cyntec: PIFE20161B	L	0.47	$\mu$ H
			DCR (Series R)	40	m $\Omega$
C <sub>IN</sub>	10 $\mu$ F, 10%, 10 V, X5R, 0603	TDK: C1608X5R1A106K	C	10	$\mu$ F
C <sub>OUT</sub>	2 x 22 $\mu$ F, 20%, 6.3 V, X5R, 0603	TDK: C1608X5R0J226M	C	44	$\mu$ F

## Pin Configuration

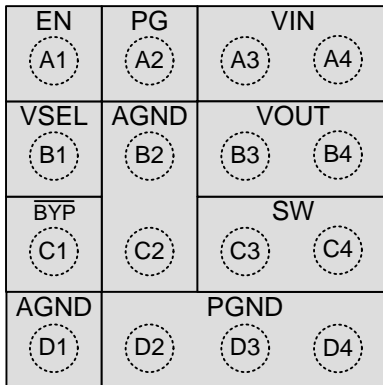


Figure 3. Top Through View (Bumps Down)

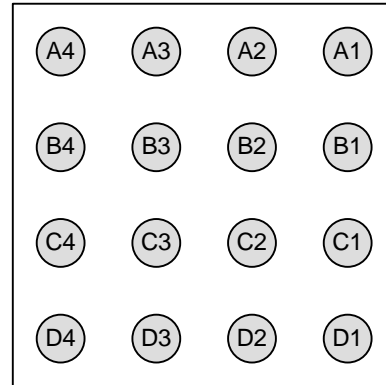


Figure 4. Bottom View (Bumps Up)

## Pin Definitions

Pin #	Name	Description
A1	EN	<b>Enable.</b> When this pin is HIGH, the circuit is enabled. <sup>(2)</sup>
A2	PG	<b>Power Good.</b> This is an open-drain output. PG is actively pulled LOW if output falls out of regulation due to overload or if thermal protection threshold is exceeded.
A3–A4	VIN	<b>Input Voltage.</b> Connect to Li-Ion battery input power source. <sup>(2)</sup>
B1	VSEL	<b>Output Voltage Select.</b> When boost is running, this pin can be used to select output voltage.
B2, C2 D1	AGND	<b>Analog Ground.</b> This is the signal ground reference for the IC. All voltage levels are measured with respect to this pin.
B3–B4	VOUT	<b>Output Voltage.</b> Place C <sub>OUT</sub> as close as possible to the device.
C1	$\overline{\text{BYP}}$	<b>Bypass.</b> This pin can be used to activate Forced Bypass Mode. When this pin is LOW, the bypass switches (Q3 and Q1) are turned on and the IC is otherwise inactive.
C3–C4	SW	<b>Switching Node.</b> Connect to inductor.
D2–D4	PGND	<b>Power Ground.</b> This is the power return for the IC. The C <sub>OUT</sub> bypass capacitor should be returned with the shortest path possible to these pins.

**Note:**

- The EN pin can be tied to VIN, but it is recommended to tie EN to the 1.8 V logic voltage.

## 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
$V_{IN}$	$V_{IN}$ Input Voltage		-0.3	6.5	V
$V_{OUT}$	$V_{OUT}$ Output Voltage			6.0	V
	SW Node	DC	-0.3	8.0	V
		Transient: 10 ns, 3 MHz	-1.0	8.0	V
	Other Pins		-0.3	6.5 <sup>(3)</sup>	V
ESD	Electrostatic Discharge Protection Level	Human Body Model per JESD22-A114	3.0		kV
		Charged Device Model per JESD22-C101	1.5		kV
$T_J$	Junction Temperature		-40	+150	°C
$T_{STG}$	Storage Temperature		-65	+150	°C
$T_L$	Lead Soldering Temperature, 10 Seconds			+260	°C

### Note:

- Lesser of 6.5 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	2.35	5.50	V
$I_{OUT}$	Output Current	0	1500	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 Fairchild evaluation boards (1 oz copper on all layers). Special attention must be paid not to exceed junction temperature  $T_{J(max)}$  at a given ambient temperature  $T_A$ .

Symbol	Parameter	Typical	Unit
$\theta_{JA}$	Junction-to-Ambient Thermal Resistance	80	°C/W
$\theta_{JB}$	Junction-to-Board Thermal Resistance	42	

## Electrical Specifications

Recommended operating conditions, unless otherwise noted, circuit per Figure 1,  $V_{IN} = 2.35\text{ V}$  to  $V_{OUT}$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$ . Typical values are given  $V_{IN} = 3.0\text{ V}$  and  $T_A = 25^\circ\text{C}$ .

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$I_Q$	$V_{IN}$ Quiescent Current	Bypass Mode $V_{OUT}=3.5\text{ V}$ , $V_{IN}=4.2\text{ V}$		140	190	$\mu\text{A}$
		Boost Mode $V_{OUT}=3.5\text{ V}$ , $V_{IN}=2.5\text{ V}$		150	250	$\mu\text{A}$
		Shutdown: $EN=0$ , $V_{IN}=3.0\text{ V}$		1.5	5.0	$\mu\text{A}$
		Forced Bypass Mode, $V_{IN}=3.5\text{ V}$	Low IQ		4	10
$I_{LK}$	$V_{OUT}$ to $V_{IN}$ Reverse Leakage	$V_{OUT}=5\text{ V}$ , $EN=0$		0.2	1.0	$\mu\text{A}$
$I_{LK\_OUT}$	$V_{OUT}$ Leakage Current	$V_{OUT}=0$ , $EN=0$ , $V_{IN}=4.2\text{ V}$		0.1	1.0	$\mu\text{A}$
$V_{UVLO}$	Under-Voltage Lockout	$V_{IN}$ Rising		2.20	2.35	V
$V_{UVLO\_HYS}$	Under-Voltage Lockout Hysteresis			200		mV
$V_{PG(OL)}$	PG Low	$I_{PG}=5\text{ mA}$			0.4	V
$I_{PG\_LK}$	PG Leakage Current	$V_{PG}=5\text{ V}$			1	$\mu\text{A}$
$V_{IH}$	Logic Level High $EN$ , $V_{SEL}$ , $\overline{BYP}$		1.2			V
$V_{IL}$	Logic Level Low $EN$ , $V_{SEL}$ , $\overline{BYP}$				0.4	V
$R_{LOW}$	Logic Control Pin Pull Downs (LOW Active)	$\overline{BYP}$ , $V_{SEL}$ , $EN$		300		$k\Omega$
$I_{PD}$	Weak Current Source Pull-Down	$\overline{BYP}$ , $V_{SEL}$ , $EN$		100		nA
$V_{REG}$	Output Voltage Accuracy	Target $V_{OUT}$ relative to GND, DC, $V_{OUT}-V_{IN} > 100\text{ mV}$	-2		4	%
$V_{TRSP}$	Load Transient Response	500 – 1250 mA, $V_{IN}=3.0\text{ V}$		$\pm 4$		%
$t_{ON}$	On-Time	$V_{IN}=3.0\text{ V}$ , $V_{OUT}=3.5\text{ V}$ , Load $> 1\text{ A}$		80		ns
$f_{SW}$	Switching Frequency	$V_{IN}=3.0\text{ V}$ , $V_{OUT}=3.5\text{ V}$ , Load $= 1\text{ A}$	2.0	2.5	3.0	MHz
$I_{V\_LIM}$	Boost Valley Current Limit	$V_{IN}=2.6\text{ V}$	3.3	3.7	4.1	A
$I_{V\_LIM\_SS}$	Boost Valley Current Limit During SS	$V_{IN}=2.6\text{ V}$		1.8		A
$I_{SS\_PK}$	Soft-Start Input Current Limit	LIN1	Fast	900		mA
		LIN2	Fast	1800		mA
$t_{SS}$	Soft-Start EN HIGH to Regulation	Fast, 50 $\Omega$ Load		600		$\mu\text{s}$
$V_{OVP}$	Output Over-Voltage Protection Threshold			6.0	6.3	V
$V_{OVP\_HYS}$	Output Over-Voltage Protection Hysteresis			300		mV
$R_{DS(ON)N}$	N-Channel Boost Switch $R_{DS(ON)}$	$V_{IN}=3.5\text{ V}$		85	120	$m\Omega$
$R_{DS(ON)P}$	P-Channel Sync Rectifier $R_{DS(ON)}$	$V_{IN}=3.5\text{ V}$		65	85	$m\Omega$
$R_{DS(ON)BYP}$	P-Channel Bypass Switch $R_{DS(ON)}$	$V_{IN}=3.5\text{ V}$		65	85	$m\Omega$
$T_{120A}$	T120 Activation Threshold			120		$^\circ\text{C}$
$T_{120R}$	T120 Release Threshold			100		$^\circ\text{C}$
$T_{150T}$	T150 Threshold			150		$^\circ\text{C}$
$T_{150H}$	T150 Hysteresis			20		$^\circ\text{C}$
$t_{RST}$	FAULT Restart Timer			20		ms

## Typical Characteristics

Unless otherwise specified;  $V_{IN} = 3.0\text{ V}$ ,  $V_{OUT} = 3.5\text{ V}$ ,  $V_{SEL}=0\text{ V}$ , and  $T_A = 25^\circ\text{C}$ ; circuit and components according to Figure 1.

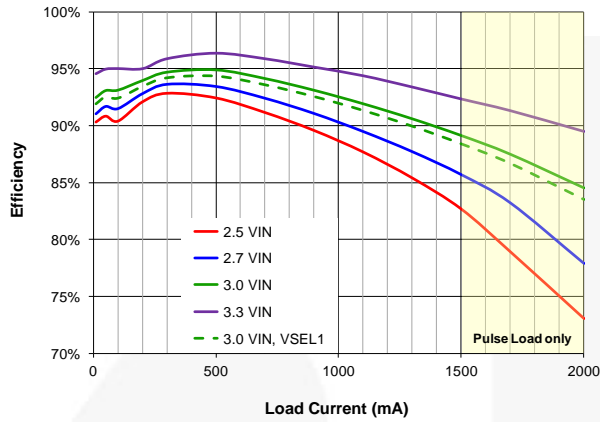


Figure 5. Efficiency vs. Load Current and Input Voltage

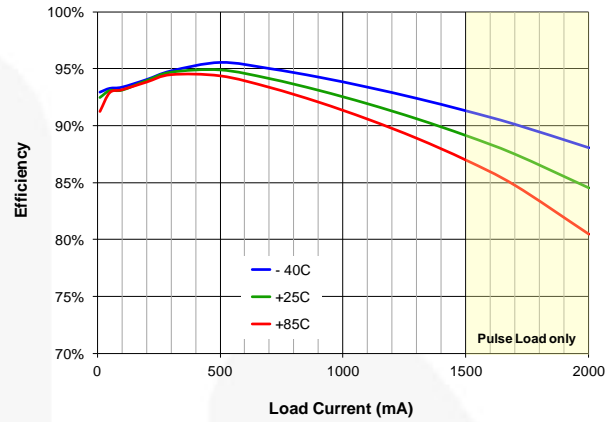


Figure 6. Efficiency vs. Load Current and Temperature

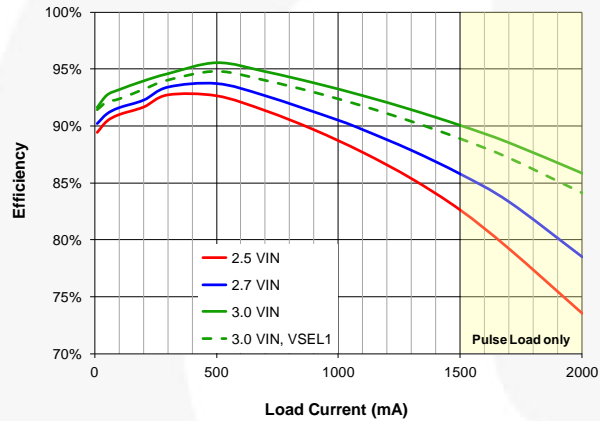


Figure 7. Efficiency vs. Load Current and Input Voltage,  $V_{OUT}=3.3\text{ V}$

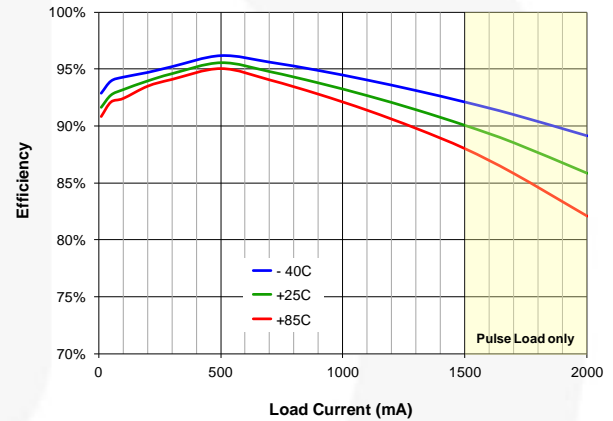


Figure 8. Efficiency vs. Load Current and Temperature,  $V_{OUT}=3.3\text{ V}$

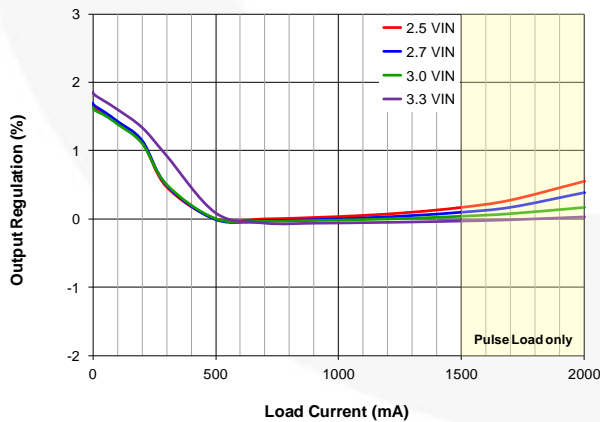


Figure 9. Output Regulation vs. Load Current and Input Voltage (Normalized to  $3.0\text{ V}_{IN}$ , 500 mA Load)

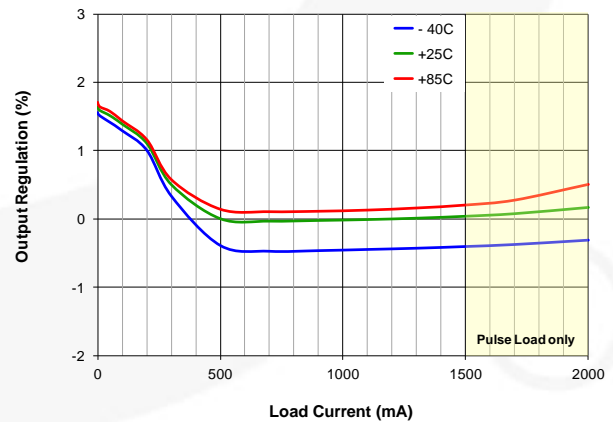
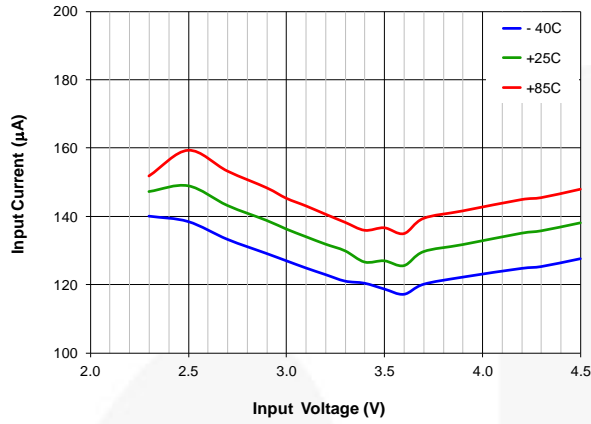


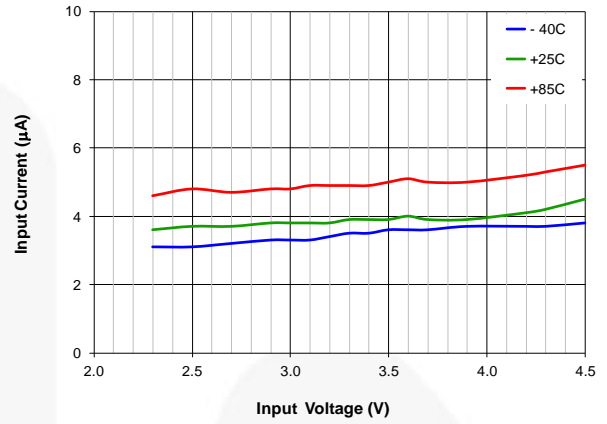
Figure 10. Output Regulation vs. Load Current and Temperature (Normalized to  $3.0\text{ V}_{IN}$ , 500 mA Load,  $T_A=25^\circ\text{C}$ )

## Typical Characteristics (Continued)

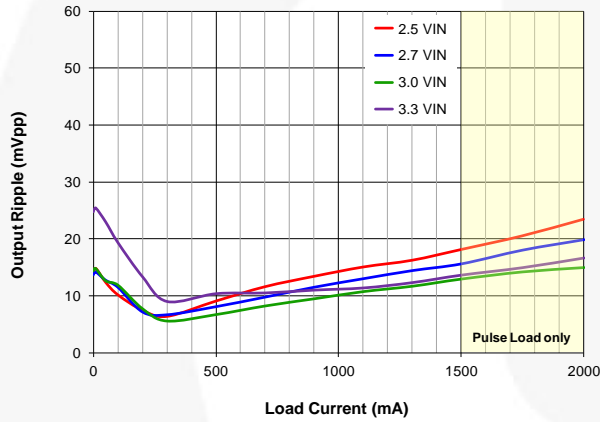
Unless otherwise specified;  $V_{IN} = 3.0\text{ V}$ ,  $V_{OUT} = 3.5\text{ V}$ ,  $V_{SEL} = 0\text{ V}$ , and  $T_A = 25^\circ\text{C}$ ; circuit and components according to Figure 1.



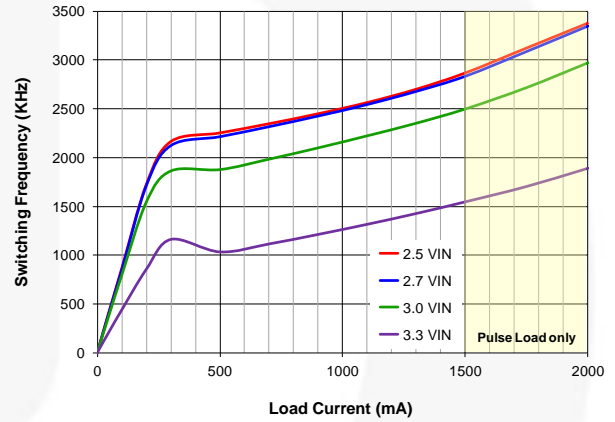
**Figure 11. Quiescent Current vs. Input Voltage and Temperature, Auto Bypass**



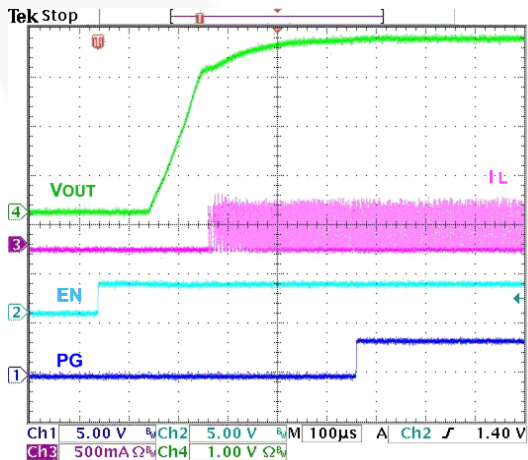
**Figure 12. Quiescent Current vs. Input Voltage, Temperature, Forced Bypass (Low  $I_q$ )**



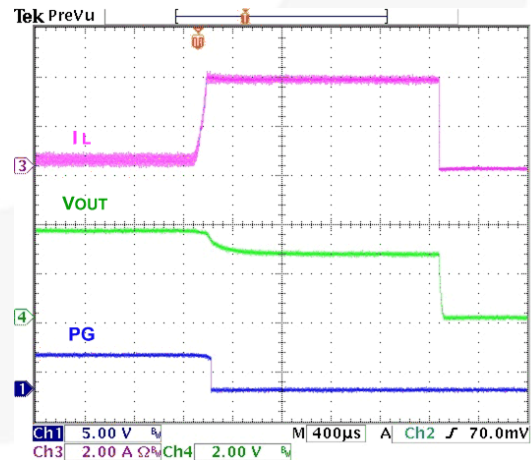
**Figure 13. Output Ripple vs. Load Current and Input Voltage**



**Figure 14. Switching Frequency vs. Load Current and Input Voltage**



**Figure 15. Startup, 50  $\Omega$  Load**



**Figure 16. Overload Protection**

### Typical Characteristics (Continued)

Unless otherwise specified;  $V_{IN} = 3.0\text{ V}$ ,  $V_{OUT} = 3.5\text{ V}$ ,  $V_{SEL} = 0\text{ V}$ , and  $T_A = 25^\circ\text{C}$ ; circuit and components according to Figure 1.

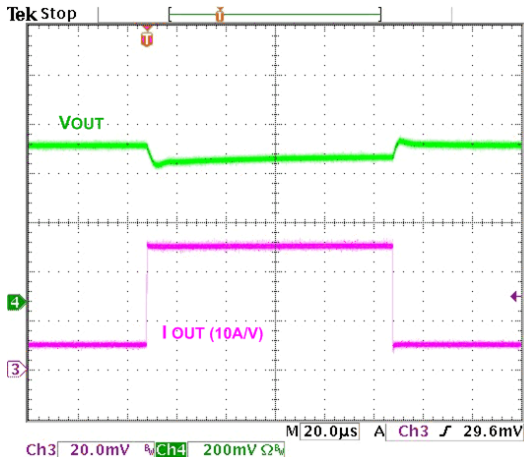


Figure 17. Load Transient, 100-500 mA, 100 ns Edge

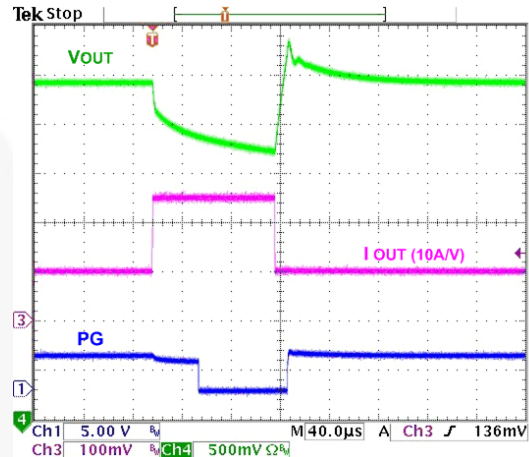


Figure 18. Transient Overload, 1.0-2.5 A, 100 ns Edge

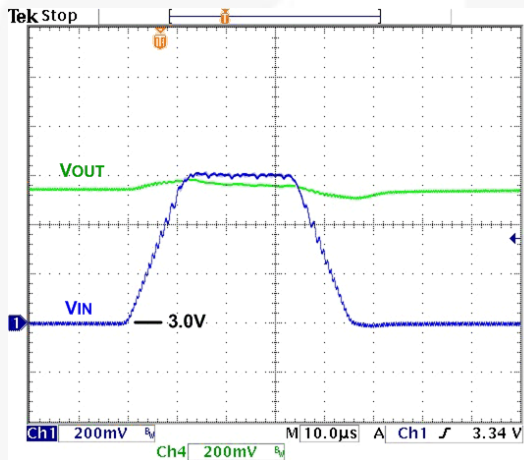


Figure 19. Line Transient, 3.0-3.6  $V_{IN}$ , 10  $\mu\text{s}$  Edge, 1.0 A Load

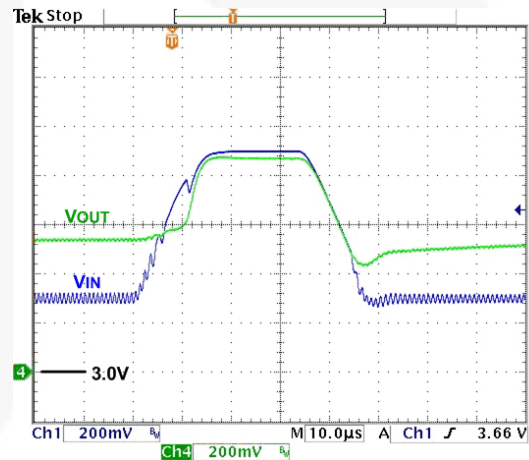


Figure 20. Line Transient, 3.3-3.9  $V_{IN}$ , 10  $\mu\text{s}$  Edge, 1.0 A Load

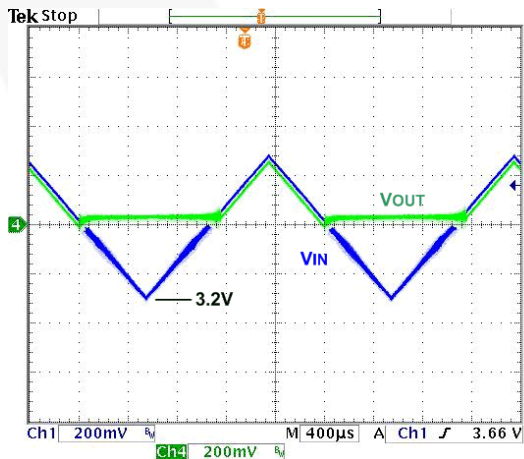


Figure 21 Bypass Entry / Exit, Slow  $V_{IN}$  Ramp 1 ms Edge, 500 mA Load, 3.2 - 3.8  $V_{IN}$

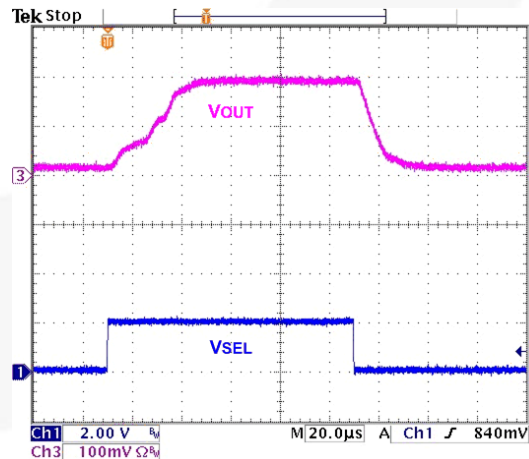


Figure 22.  $V_{SEL}$  Step,  $V_{IN} = 3.0\text{ V}$ , 500 mA Load

## Circuit Description

FAN48632 is a synchronous boost regulator, typically operating at 2.5 MHz in Continuous Conduction Mode (CCM), which occurs at moderate to heavy load current and low  $V_{IN}$  voltages. The regulator includes a Bypass Mode that activates when  $V_{IN}$  is above the boost regulator's set point.

In anticipation of a heavy load transition, the set point can be adjusted upward by fixed amounts with the VSEL pin to reduce the required system headroom during lighter-load operation to save power.

**Table 2. Operating States**

Mode	Description	Invoked When
LIN	Linear Startup	$V_{IN} > V_{OUT}$
SS	Boost Soft-Start	$V_{OUT} < V_{OUT(MIN)}$
BST	Boost Operating Mode	$V_{OUT} = V_{OUT(MIN)}$
BPS	True Bypass Mode	$V_{IN} > V_{OUT(MIN)}$

### Boost Mode

The FAN48632 uses a current-mode modulator to achieve excellent transient response and smooth transitions between CCM and Discontinuous Conduction Mode (DCM) operation. During CCM operation, the device maintains a switching frequency of about 2.5 MHz. In light-load operation (DCM), frequency is reduced to maintain high efficiency.

**Table 3. Boost Startup Sequence**

Start State	Entry	Exit	End State	Timeout ( $\mu$ s)
LIN1	$V_{IN} > UVLO$ , EN=1	$V_{OUT} > V_{IN} - 300$ mV	SS	
			LIN2	512
LIN2	LIN1 Exit	$V_{OUT} > V_{IN} - 300$ mV	SS	
		TIMEOUT	FAULT	1024
SS	LIN1 or LIN2 Exit	$V_{OUT} = V_{OUT(MIN)}$	BST	
		OVERLOAD TIMEOUT	FAULT	64

### Shutdown and Startup

If EN is LOW, all bias circuits are off and the regulator is in Shutdown Mode. During shutdown, current flow is prevented from  $V_{IN}$  to  $V_{OUT}$ , as well as reverse flow from  $V_{OUT}$  to  $V_{IN}$ . During startup, it is recommended to keep DC current draw below 500 mA.

#### LIN State

When EN is HIGH and  $V_{IN} > UVLO$ , the regulator attempts to bring  $V_{OUT}$  within 300 mV of  $V_{IN}$  using the internal fixed current source from  $V_{IN}$  (Q3). The current is limited to LIN1 set point.

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

In LIN2 Mode, the current source is incremented to 2 A. If  $V_{OUT}$  fails to reach  $V_{IN} - 300$  mV after 1024  $\mu$ s, a fault condition is declared.

#### SS State

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

During SS state,  $V_{OUT}$  is ramped up by stepping the internal reference. If  $V_{OUT}$  fails to reach regulation during the SS ramp sequence for more than 64  $\mu$ s, a fault condition is declared. If large  $C_{OUT}$  is used, the reference is automatically stepped slower to avoid excessive input current draw.

#### BST State

This is a normal operating state of the regulator.

#### BPS State

If  $V_{IN}$  is above  $V_{REG}$  when the SS Mode successfully completes, the device transitions directly to BPS Mode.

### FAULT State

The regulator enters the FAULT state under any of the following conditions:

- $V_{OUT}$  fails to achieve the voltage required to advance from LIN state to SS state.
- $V_{OUT}$  fails to achieve the voltage required to advance from SS state to BST state.
- Boost current limit triggers for 2 ms during the BST state.
- $V_{DS}$  protection threshold is exceeded during BPS state.

Once a fault is triggered, the regulator stops switching and presents a high-impedance path between  $V_{IN}$  and  $V_{OUT}$ . After waiting 20 ms, a restart is attempted.

### Power Good

Power good is 0 FAULT, 1 POWER GOOD, open-drain input.

The Power good pin is provided for signaling the system when the regulator has successfully completed soft-start and no faults have occurred. Power good also functions as an early warning flag for high die temperature and overload conditions.

- PG is released HIGH when the soft-start sequence is successfully completed.
- PG is pulled LOW when PMOS current limit has triggered for 64  $\mu$ s OR the die the temperature exceeds 120°C. PG is re-asserted when the device cools below to 100°C.
- Any FAULT condition causes PG to be de-asserted.

### Over-Temperature

The regulator shuts down when the die temperature exceeds 150°C. Restart occurs when the IC has cooled by approximately 20°C.

## Bypass Operation

In normal operation, the device automatically transitions from Boost Mode to Bypass Mode, if  $V_{IN}$  goes above target  $V_{OUT}$ . In Bypass Mode, the device fully enhances both Q1 and Q3 to provide a very low impedance path from  $V_{IN}$  to  $V_{OUT}$ . Entry to the Bypass Mode is triggered by condition where  $V_{IN} > V_{OUT}$  and no switching has occurred during past 5  $\mu$ s. To soften the entry to Bypass Mode, Q3 is driven as a linear current source for the first 5  $\mu$ s. Bypass Mode exit is triggered when  $V_{OUT}$  reaches the target  $V_{OUT}$  voltage. During Automatic Bypass Mode, the device is short-circuit protected by voltage comparator tracking the voltage drop from  $V_{IN}$  to  $V_{OUT}$ ; if the drop exceeds 200 mV, a FAULT is declared.

With sufficient load to enforce CCM operation, the Bypass Mode to Boost Mode transition occurs at the target  $V_{OUT}$ . The corresponding input voltage at the transition point is:

$$V_{IN} \leq V_{OUT} + I_{LOAD} \cdot (DCR_L + R_{DS(ON)P}) \parallel R_{DS(ON)BYP} \quad \text{EQ. 1}$$

The Bypass Mode entry threshold has 25 mV hysteresis imposed at  $V_{OUT}$  to prevent cycling between modes. The transition from Boost Mode to Bypass Mode occurs at the target  $V_{OUT}+25$  mV. The corresponding input voltage is:

$$V_{IN} \geq V_{OUT} + 25mV + I_{LOAD} \cdot (DCR_L + R_{DS(ON)P}) \quad \text{EQ. 2}$$

## Forced Bypass

Entry to Forced Bypass Mode initiates with a current limit on Q3 and then proceeds to a true bypass state. To prevent reverse current to the battery, the device waits until output discharges below  $V_{IN}$  before entering Forced Bypass Mode.

Low- $I_Q$  Forced Bypass Mode is available for the FAN48632. After the transition is complete, most of the internal circuitry is disabled to minimize quiescent current draw. OCP, UVLO, output OVP and over-temperature protections are inactive in Forced Bypass Mode.

In Forced Bypass Mode,  $V_{OUT}$  can follow  $V_{IN}$  below  $V_{OUT(MIN)}$ .

## VSEL

$V_{SEL}$  can be asserted in anticipation of a positive load transient. Raising  $V_{SEL}$  increases  $V_{OUT(MIN)}$  by a fixed amount and  $V_{OUT}$  is stepped to the corresponding target output voltage in 20  $\mu$ s. The functionality can also be utilized to mitigate undershoot during severe line transients, while minimizing  $V_{OUT}$  during more benign operating conditions to save power.

## Application Information

### Output Capacitance (C<sub>OUT</sub>)

#### Stability

The effective capacitance (C<sub>EFF</sub>) of small, high-value, ceramic capacitors decreases as bias voltage increases.

FAN48632 is guaranteed for stable operation with the minimum value of C<sub>EFF</sub> (C<sub>EFF(MIN)</sub>) of 14 μF.

C<sub>EFF</sub> varies with manufacturer, material, and case size.

#### Inductor Selection

The recommended nominal inductance value is 0.47 μH.

FAN48632 employs valley-current limiting; peak inductor current can exceed 4.4 A for a short duration during overload conditions. Saturation effects cause the inductor current ripple to become higher under high loading as only valley of the inductor current ripple is controlled..

#### Startup

Input current limiting is in effect during soft-start, which limits the current available to charge C<sub>OUT</sub> and any additional capacitance on the V<sub>OUT</sub> line. If the output fails to achieve regulation within the limits described in the Startup section, a FAULT occurs, causing the circuit to shut down then restart after a significant time period. If the total combined output capacitance is very high, the circuit may not start on the first attempt, but eventually achieves regulation if no load is present. If a high-current load and high capacitance are both present during soft-start, the circuit may fail to achieve regulation and continually attempts soft-start, only to have the output capacitance discharged by the load when in a FAULT state.

#### Output Voltage Ripple

Output voltage ripple is inversely proportional to C<sub>OUT</sub>. During t<sub>ON</sub>, when the boost switch is on, all load current is supplied by C<sub>OUT</sub>. Output ripple is calculated as:

$$V_{RIPPLE (P-P)} = t_{ON} \cdot \frac{I_{LOAD}}{C_{OUT}} \quad \text{EQ. 3}$$

and

$$t_{ON} = t_{SW} \cdot D = t_{SW} \cdot \left(1 - \frac{V_{IN}}{V_{OUT}}\right) \quad \text{EQ. 4}$$

therefore:

$$V_{RIPPLE (P-P)} = t_{SW} \cdot \left(1 - \frac{V_{IN}}{V_{OUT}}\right) \cdot \frac{I_{LOAD}}{C_{OUT}} \quad \text{EQ. 5}$$

and

$$t_{SW} = \frac{1}{f_{SW}} \quad \text{EQ. 6}$$

As can be seen from EQ. 5, the maximum V<sub>RIPPLE</sub> OCCURS when V<sub>IN</sub> is at minimum and I<sub>LOAD</sub> is at maximum.

### 2.0 A Pulsed Loads for GSM Applications

The FAN48632 can support 2 A load pulses for GSM and GSM Edge applications, according to the minimum V<sub>IN</sub> levels shown in Figure 23.

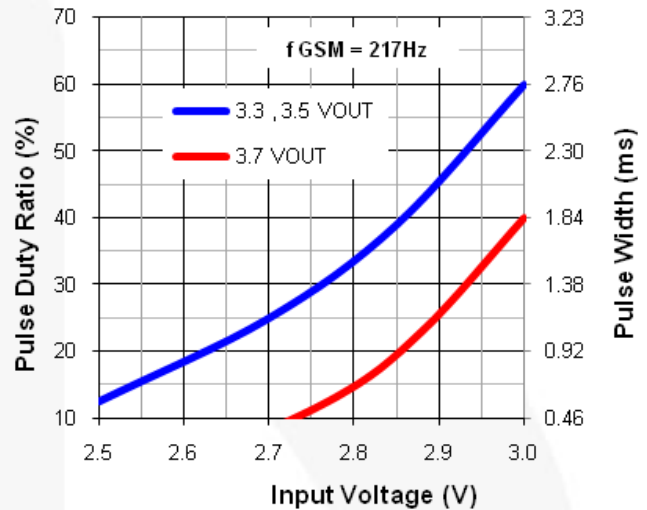


Figure 23. Minimum V<sub>IN</sub> for 2 A GSM Pulse, 3.5 V<sub>OUT</sub>

Results shown use circuit/components of Figure 1 with device mounted on standard evaluation platform (layout Figure 24).

### Layout Recommendation

To minimize spikes at V<sub>OUT</sub>, C<sub>OUT</sub> must be placed as close as possible to PGND and V<sub>OUT</sub>, as shown in Figure 24. The associated PGND and V<sub>OUT</sub> routes are best made directly on the top copper layer, rather than thru vias.

For thermal reasons, it is suggested to maximize the pour area for all planes other than SW. Especially the ground pour should be set to fill all available PCB surface area and tied to internal layers with a cluster of thermal vias.

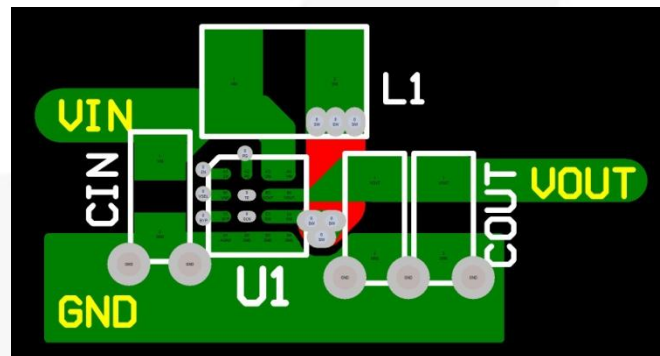


Figure 24. Layout Recommendation

## Physical Dimensions

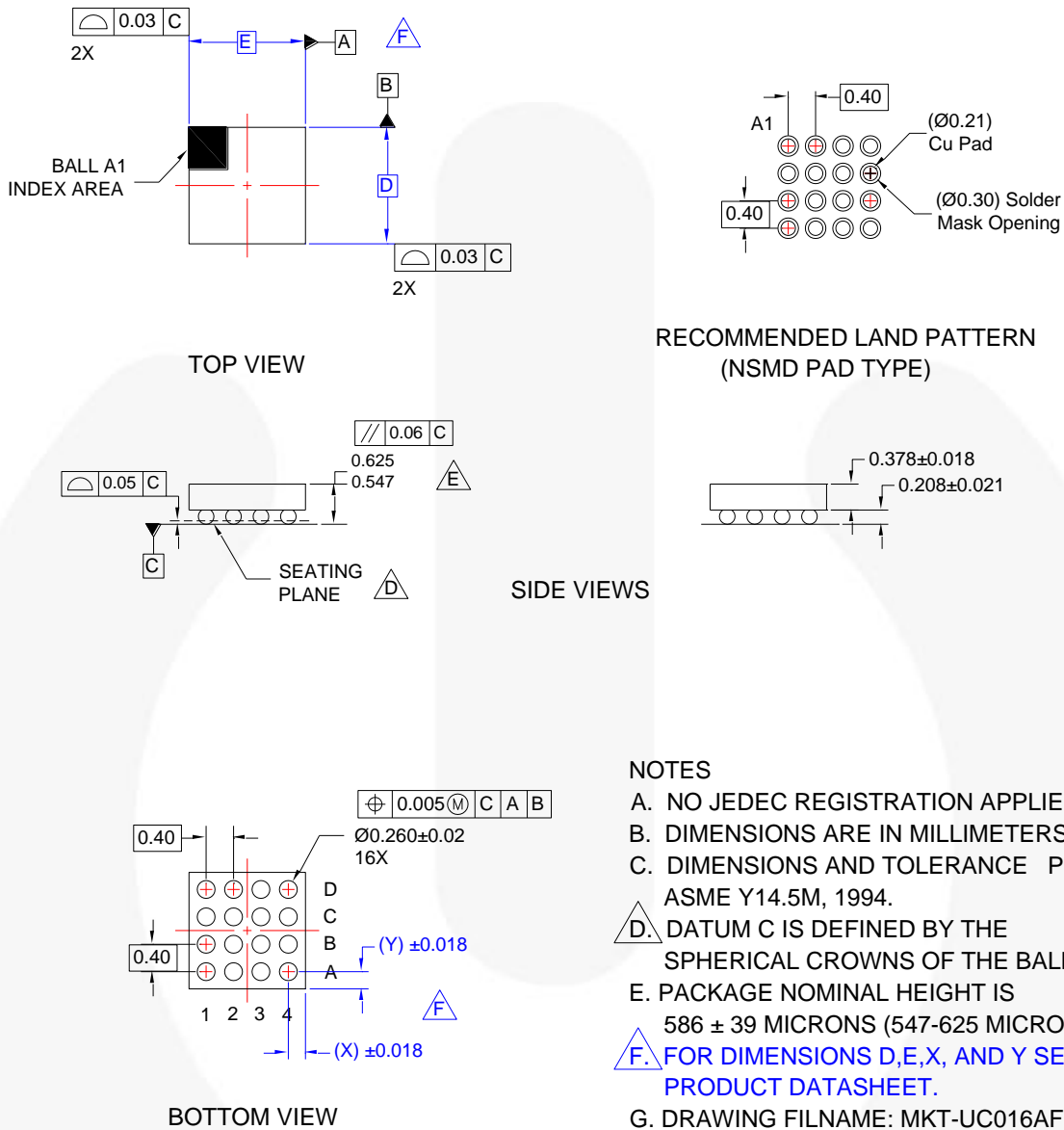


Figure 25. 16-Ball, 4x4 Array, 0.4 mm Pitch, 250 μm Ball, Wafer-Level Chip-Scale Package (WLCSP)

## Product-Specific Dimensions

D	E	X	Y
1.780 ±0.030	1.780 ±0.030	0.290	0.290

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:  
<http://www.fairchildsemi.com/dwg/UC/UC016AF.pdf>

For current packing container specifications, visit Fairchild Semiconductor's online packaging area:  
[http://www.fairchildsemi.com/packing\\_dwg/PKG-UC016AF.pdf](http://www.fairchildsemi.com/packing_dwg/PKG-UC016AF.pdf)



**TRADEMARKS**

The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

- |                          |  |                                       |                  |
|--------------------------|--|---------------------------------------|------------------|
| AccuPower™               | F-PFS™   |                                       |                  |
| AX-CAP®*                 | FRFET®   | PowerTrench®                          | TinyBoost®       |
| BitSiC™                  | Global Power Resource SM                       | PowerXS™                              | TinyBuck®        |
| Build it Now™            | GreenBridge™                                   | Programmable Active Droop™            | TinyCalc™        |
| CorePLUS™                | Green FPS™                                     | QFET®                                 | TinyLogic®       |
| CorePOWER™               | Green FPS™ e-Series™                           | QS™                                   | TINYOPTO™        |
| CROSSVOLT™               | Gmax™  | Quiet Series™                         | TinyPower™       |
| CTL™                     | GTO™   | RapidConfigure™                       | TinyPWM™         |
| Current Transfer Logic™  | IntelliMAX™                                    |                                       | TinyWire™        |
| DEUXPEED®                | ISOPLANAR™                                     | Saving our world, 1mW/W/KW at a time™ | TranSiC™         |
| Dual Cool™               | Making Small Speakers Sound Louder and Better™ | SignalWise™                           | TriFault Detect™ |
| EcoSPARK®                | MegaBuck™                                      | SmartMax™                             | TRUECURRENT®*    |
| EfficientMax™            | MICROCOUPLER™                                  | SMART START™                          | μSerDes™         |
| ESBC™                    | MicroFET™                                      | Solutions for Your Success™           |                  |
|                          | MicroPak™                                      | SPM®                                  | UHC®             |
| Fairchild®               | MicroPak2™                                     | STEALTH™                              | Ultra FRFET™     |
| Fairchild Semiconductor® | MillerDrive™                                   | SuperFET®                             | UniFET™          |
| FACT Quiet Series™       | MotionMax™                                     | SuperSOT™-3                           | VCX™             |
| FACT®                    | mWSaver®                                       | SuperSOT™-6                           | VisualMax™       |
| FAST®                    | OptoHi™  | SuperSOT™-8                           | VoltagePlus™     |
| FastvCore™               | OPTOLOGIC®                                     | SupreMOS®                             | XS™              |
| FETBench™                | OPTOPLANAR®                                    | SyncFET™                              | 仙童™              |
| FPS™                     |  | Sync-Lock™                            |                  |

\* Trademarks of System General Corporation, used under license by Fairchild Semiconductor.

**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. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

**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 FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

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, and (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 a significant injury of the user.
2. A critical component in 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.

**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](http://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.

**PRODUCT STATUS DEFINITIONS**

**Definition of Terms**

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

Rev. 168

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](http://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](mailto: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](http://www.onsemi.com)  
**Order Literature:** <http://www.onsemi.com/orderlit>  
For additional information, please contact your local  
Sales Representative

## Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

-  [View FAN48632UC35X on WIN SOURCE](#)
-  [Fairchild/ON Semiconductor Information](#)

## Optimize Your Supply Chain with WIN SOURCE Solutions

-  Global Sourcing Solution
-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management