



# FAN25801 250 mA, Low-I<sub>Q</sub>, Low-Noise, LDO Regulator

## Features

- V<sub>IN</sub>: 2.3 V to 5.5 V
- V<sub>OUT</sub> = 5.14 V (I<sub>OUT</sub> Max. = 250 mA)
- Output Noise Density at 250 mA and 10 kHz = 20 nV/√Hz (Integrated 10 μVrms)
- Low I<sub>Q</sub> of 17 μA in Regulation and Low-I<sub>Q</sub> Dropout Mode with Optimized Dropout Transitions
- <70 mV Dropout Voltage at 250 mA Load
- Controlled Soft-Start to Reduce Inrush Current
- Thermal Shutdown Protection (TSD)
- Input Under-Voltage Lockout (UVLO)
- Short-Circuit Protection (SCP)
- Stable with Two 1.5 μF, 0201 Ceramic Capacitors at V<sub>OUT</sub>
- 4-Ball WLCSP, 0.65 mm x 0.65 mm, 0.35 mm Pitch, Plated Solder, 330 μm Maximum Thickness

## Applications

- WiFi Modules
- PDA Handsets
- Smart Phones, Tablets, Portable Devices

## Description

The FAN25801 is a linear low-dropout regulator with a high PSRR (80 dB typical at 100 Hz) and low output noise (typically 10 μV<sub>RMS</sub> over a 10 Hz to 100 kHz bandwidth). The LDO can provide up to 250 mA of output current.

The enable control pin can be used to shut down the device and disconnect the output load from the input. During shutdown, the supply current drops below 1 μA.

The FAN25801 is designed to be stable with space-saving ceramic capacitors as small as 0201 case size. The FAN25801 is available in a 4-bump, 0.35 mm pitch, WLCSP package.

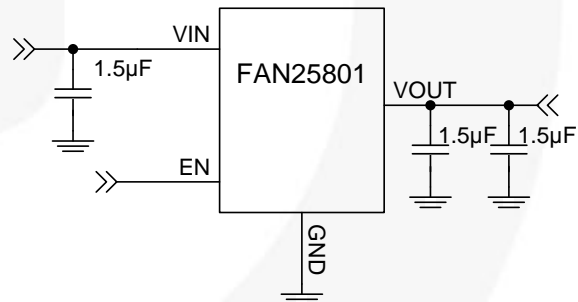


Figure 1. Typical Application

## Ordering Information

Part Number	V <sub>OUT</sub>	I <sub>OUT</sub> Max.	Operating Temperature	Package	Packing Method
FAN25801AUC514X	5.14 V	250 mA	-40°C to 85°C	4-Bump, WLCSP, 0.65 x 0.65 mm, 0.35 mm Pitch	Tape & Reel

## Block Diagram

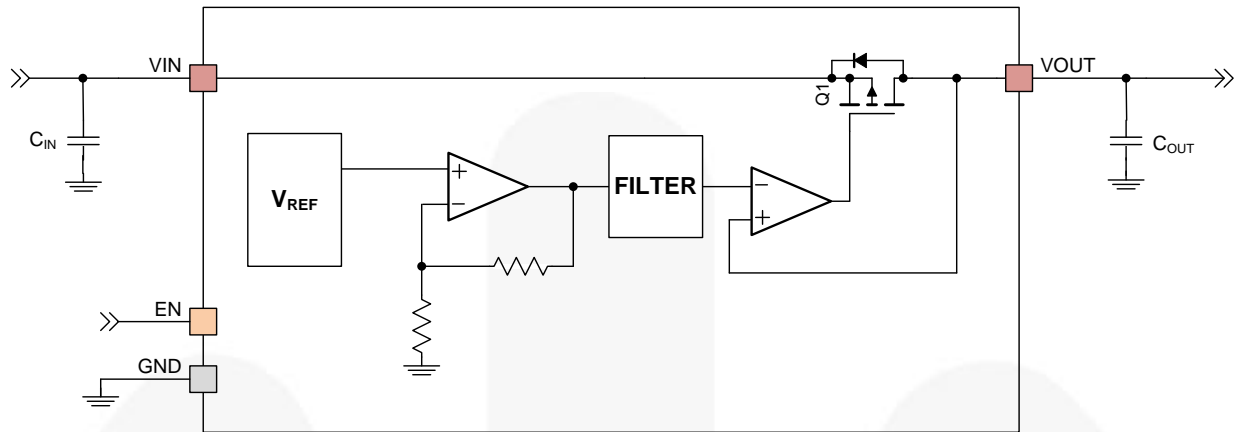


Figure 2. IC and System Block Diagram

Table 1. Recommended External Components

Component	Description	Vendor	Parameter	Typ.	Unit
C <sub>IN</sub>	1.5 μF, 6.3 V, X5R, 0201	Murata GRM033R60J155M	C	1.5 <sup>(1)</sup>	μF
C <sub>OUT</sub>	2x1.5 μF, 6.3 V, X5R, 0201	Murata GRM033R60J155M		1.5 <sup>(1)</sup>	μF
C <sub>Alternative</sub> <sup>(2)</sup>	1.0 μF, 6.3 V, X5R, 0201	Murata GRM033R60J105M		1.0 <sup>(1)</sup>	μF

### Notes:

- Capacitance value does not reflect effects of bias, tolerance, and temperature. See *Recommended Operating Conditions and Operation Description* sections for more information.
- C<sub>Alternative</sub> can be used for both C<sub>IN</sub> and C<sub>OUT</sub>. FAN25801 is stable with one 1 μF at C<sub>IN</sub> and one 1 μF at C<sub>OUT</sub>.

## Pin Configuration

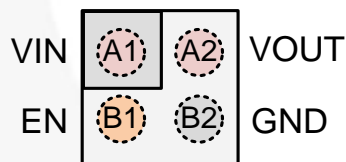


Figure 3. Top-Through View

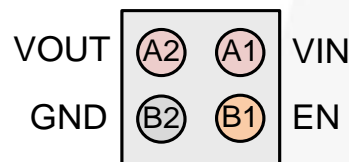


Figure 4. Bottom View

## Pin Definitions

Pin #	Name	Description
A1	VIN	<b>Input Voltage.</b> Connect to input power source and C <sub>IN</sub> .
A2	VOUT	<b>Output Voltage.</b> Connect to C <sub>OUT</sub> and load.
B1	EN	<b>Enable.</b> The device is in Shutdown Mode when this pin is LOW. No internal pull-down. Do not leave this pin floating. Recommended to not tie EN pin directly to VIN. <sup>(3)</sup>
B2	GND	<b>Ground.</b> Power and IC ground. All signals are referenced to this pin.

### Note:

- EN can be tied to VIN, but it is recommended to tie a 1.8 V logic voltage to drive it.

## 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 <sub>IN</sub>	Input Voltage with Respect to GND		-0.3	6.0	V
V <sub>CC</sub>	Voltage on Any Other Pin (with Respect to GND)		-0.3	V <sub>IN</sub> +0.3 <sup>(4)</sup>	V
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
ESD	Electrostatic Discharge Protection Level	Human Body Model, ANSI/ESDA/JEDEC JS-001-2012	4000		V
		Charged Device Model per JESD22-C101	1500		
LU	Latch Up		JESD 78D		

### Note:

4. Lesser of 6.0 V or V<sub>IN</sub> + 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.	Typ.	Max.	Unit
V <sub>IN</sub>	Supply Voltage	2.3		5.5 <sup>(5)</sup>	V
I <sub>OUT</sub>	Output Current (V <sub>OUT</sub> = 5.14 V)			250	mA
C <sub>IN</sub>	Input Capacitor (Effective Capacitance) <sup>(6)</sup>	0.4	0.8		μF
C <sub>OUT</sub>	Output Capacitor (Effective Capacitance) <sup>(6)</sup>	0.4	0.8	15.0	μF
T <sub>A</sub>	Ambient Temperature	-40		+85	°C
T <sub>J</sub>	Junction Temperature	-40		+125	°C

### Notes:

5. For V<sub>IN</sub> ≥ 5V, thermal properties of the device must be taken into account at maximum load of 250 mA; refer to θ<sub>JA</sub> thermal properties.
6. Effective capacitance, including the effects of bias, tolerance, and temperature. See the *Operation Description* section for more information.

## Thermal Properties

Junction-to-ambient thermal resistance is a function of application and board layout. This data is measured with four-layer 2s2p boards 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>.

Symbol	Parameter	Typ.	Unit
θ <sub>JA</sub>	Junction-to-Ambient Thermal Resistance	180	°C/W
Ψ <sub>JB</sub>	Junction-to-PCB Thermal Resistance	50	°C/W

## Electrical Specifications

Minimum and maximum values are at  $V_{IN} = V_{OUT} + 0.3\text{ V}$ ;  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ; and test circuit shown in Figure 1. Typical values are at  $V_{IN} = V_{OUT} + 0.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $I_{LOAD} = 10\text{ mA}$ , and  $V_{EN} = 1.8\text{ V}$ , unless otherwise noted.

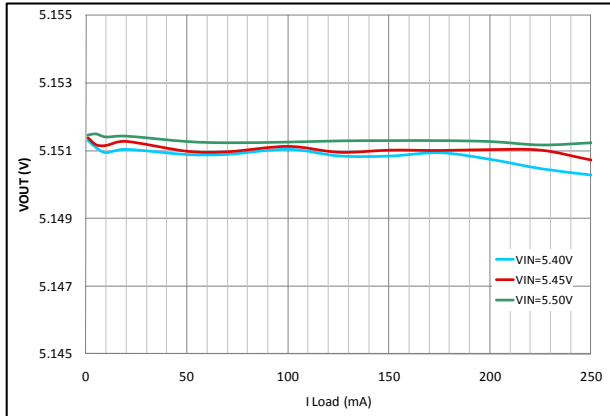
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>LDO</b>						
$I_{IN}$	$V_{IN}$ Supply Current	$5.4\text{ V} \leq V_{IN} \leq 5.5\text{ V}$ , $I_{LOAD} = 0\text{ mA}$		17.0	25.0	$\mu\text{A}$
		Dropout <sup>(8)</sup> , $I_{LOAD} = 0\text{ mA}$		18.5	30.0	
PSRR	Power Supply Rejection Ratio <sup>(7)</sup>	$I_{OUT} = 10\text{ mA}$ , $V_{IN} = 3.6\text{ V}$	$f = 50\text{ Hz}$		80	dB
			$f = 100\text{ Hz}$		80	
			$f = 1\text{ kHz}$		80	
			$f = 10\text{ kHz}$		76	
$e_n$	Output Noise Voltage Density <sup>(7)</sup>	$f = 10\text{ kHz}$	$I_{OUT} = 10\text{ mA}$		16	nV/ $\sqrt{\text{Hz}}$
			$I_{OUT} = 250\text{ mA}$		20	
$e_{n\_bw}$	Output Noise Voltage (Integrated) <sup>(7)</sup>	$f = 10\text{ Hz} - 100\text{ kHz}$	$I_{OUT} = 10\text{ mA}$		7	$\mu\text{V}_{RMS}$
			$I_{OUT} = 250\text{ mA}$		10	
$V_{DO}$	$V_{OUT}$ Dropout Voltage <sup>(8)</sup>	$V_{OUT} = V_{OUT\_TARGET} - 100\text{ mV}$ , $I_{OUT} = 250\text{ mA}$		70	110	mV
$\Delta V_{OUT}$	$V_{OUT}$ Voltage Accuracy	$5\text{ mA} \leq I_{OUT} \leq 250\text{ mA}$ , $V_{IN} = 5.4\text{ V}$ to $5.5\text{ V}$	-1.9		+1.9	%
$\Delta V_{OUT\_LOAD}$	Load Regulation	$I_{OUT} = 5\text{ mA}$ to $250\text{ mA}$ , $V_{OUT} = 5.14\text{ V}$		8	35	$\mu\text{V}/\text{mA}$
$I_{LIM}$	$V_{OUT}$ Current Limit	$I_{OUT} = 0\text{ mA} \rightarrow$ Current Limit, $V_{OUT}$ Drops by 2%, $V_{OUT} = 5.14\text{ V}$	275	323	400	mA
$I_{SD}$	Shutdown Supply Current	$V_{EN} = 0\text{ V}$ , $2.9\text{ V} \leq V_{IN} \leq 4.8\text{ V}$		0.125	1.000	$\mu\text{A}$
$V_{UVLO}$	Under-Voltage Lockout Threshold	Rising $V_{IN}$		2.1	2.3	V
$V_{UVHYS}$	Under-Voltage Lockout Hysteresis			150		mV
$t_{START}$	Startup Time	Rising EN to 95% $V_{OUT}$ , $I_{OUT} = 10\text{ mA}$		250	500	$\mu\text{s}$
TSD	Thermal Shutdown	Rising Temperature		150		$^\circ\text{C}$
		Hysteresis		20		
<b>Logic Levels: EN</b>						
$V_{IH}$	Enable High-Level Input Voltage		1.05			V
$V_{IL}$	Enable Low-Level Input Voltage				0.4	V
$I_{EN}$	Input Bias Current	$V_{EN} = 1.8\text{ V}$		0.04	1.00	$\mu\text{A}$

### Notes:

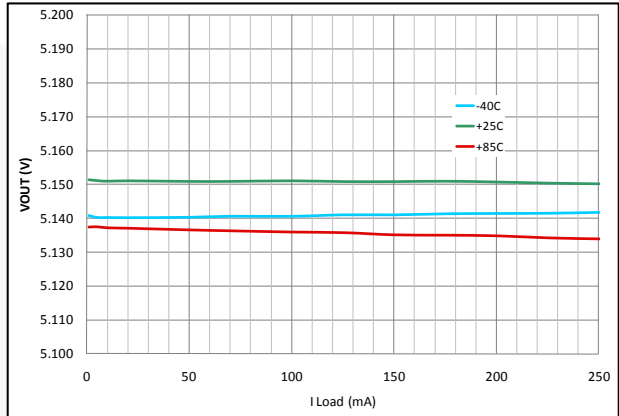
- Guaranteed by design; not tested in production.
- Dropout voltage =  $V_{IN} - V_{OUTx}$  when  $V_{OUT}$  drops more than 100 mV below the nominal regulated  $V_{OUT}$  level.

## Typical Characteristics

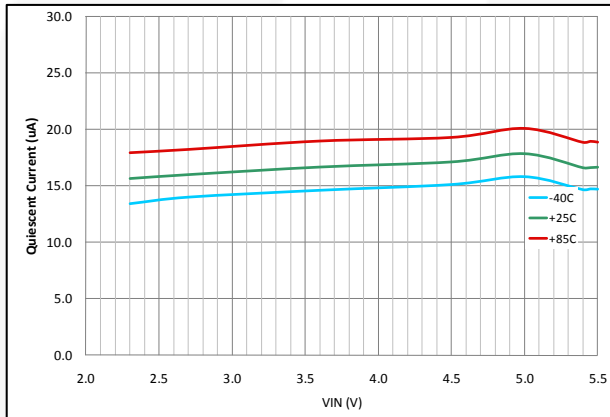
Unless otherwise specified;  $V_{IN} = V_{OUT} + 0.3\text{ V}$ ,  $V_{OUT} = 5.14\text{ V}$ ,  $V_{EN} = 1.8\text{ V}$ , and  $T_A = +25^\circ\text{C}$ .



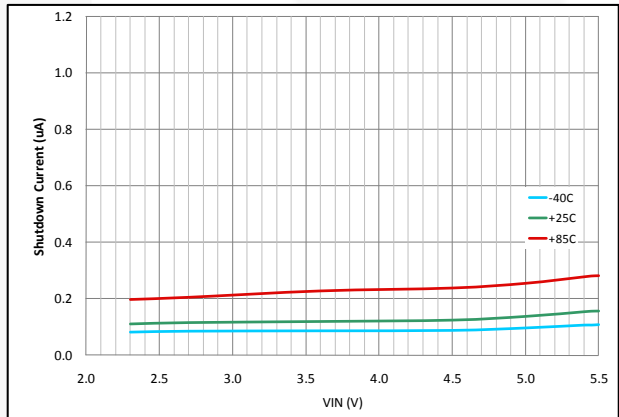
**Figure 5. Output Regulation vs. Load Current and Input Voltage**



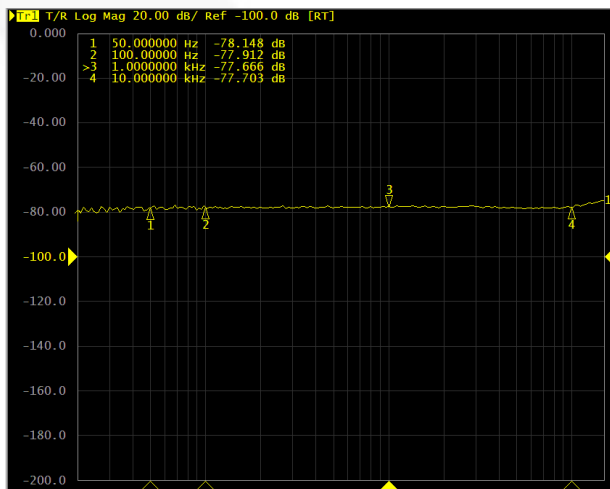
**Figure 6 Output Regulation vs. Load Current and Temperature**



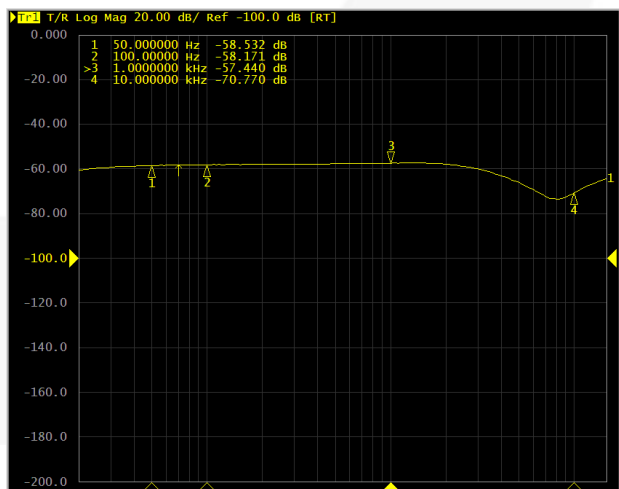
**Figure 7. Quiescent Current vs. Input Voltage and Temperature**



**Figure 8. Shutdown Current vs. Input Voltage and Temperature**



**Figure 9. PSRR vs. Frequency, 10 mA Load**



**Figure 10. PSRR vs. Frequency, 250 mA Load**

## Typical Characteristics

Unless otherwise specified;  $V_{IN} = V_{OUT} + 0.3\text{ V}$ ,  $V_{OUT} = 5.14\text{ V}$ ,  $V_{EN} = 1.8\text{ V}$ , and  $T_A = +25^\circ\text{C}$ .

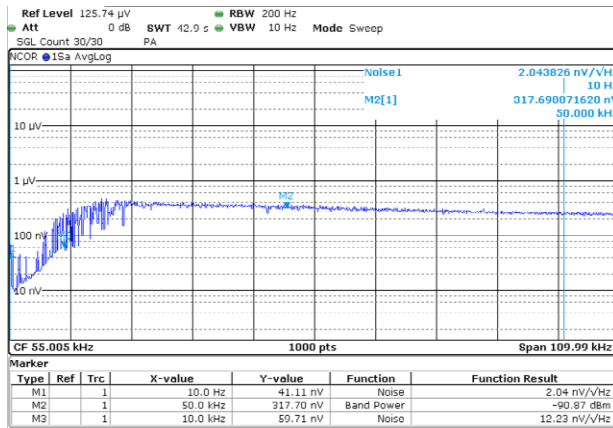


Figure 11. Output Noise Voltage vs. Frequency, 10 mA Load

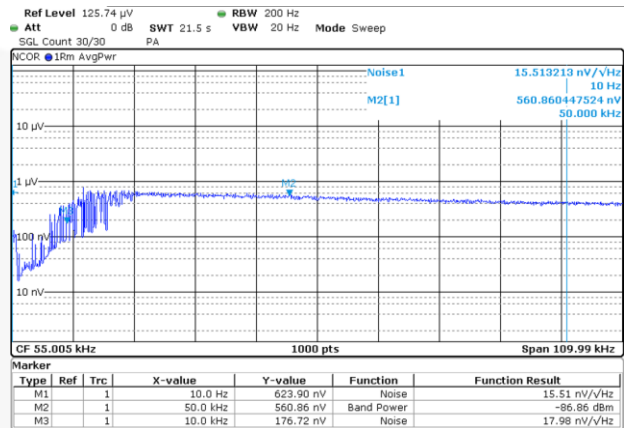


Figure 12. Output Noise Voltage vs. Frequency, 250 mA Load

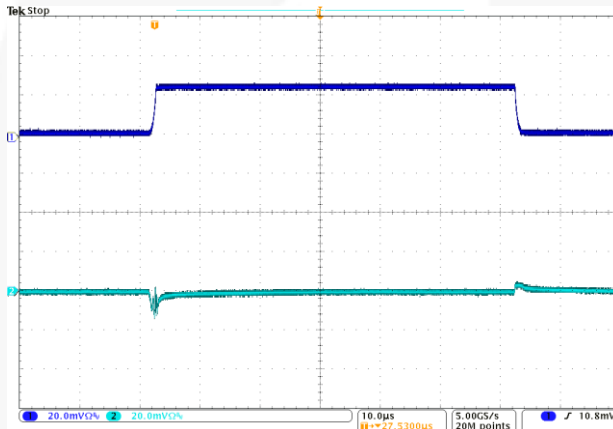


Figure 13. Load Transient,  $I_{OUT} = 10\text{ mA} \leftrightarrow 250\text{ mA}$ ,  $t_R = t_F = 1\ \mu\text{s}$

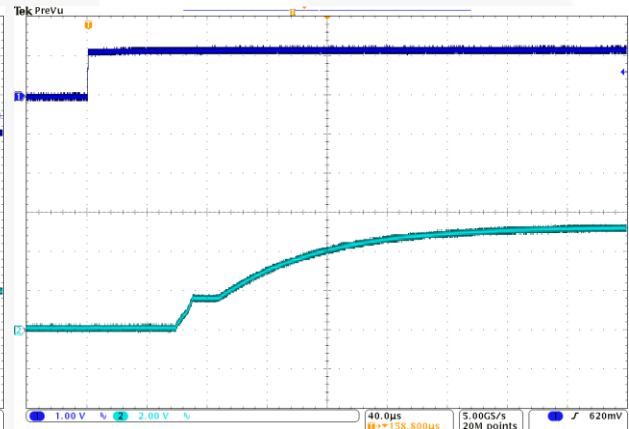


Figure 14. Startup, 10 mA Load

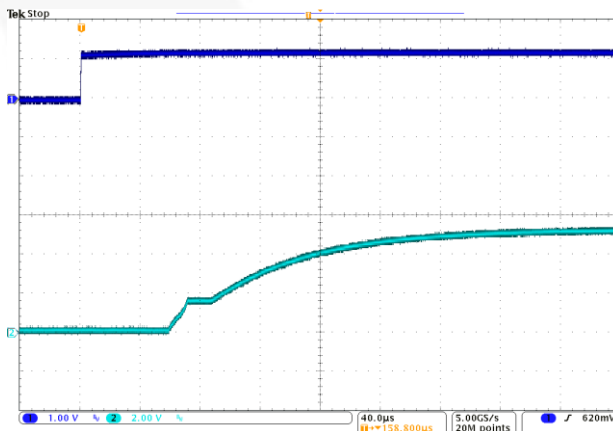


Figure 15. Startup, 250 mA Load

## Circuit Description

The FAN25801 is a linear low-dropout (LDO) regulator that has high PSRR and low output noise. The enable control pin can be used to shut down the device and disconnect the output load from the input. During shutdown, the supply current drops below 1 μA. The LDO is designed to be stable with space-saving ceramic capacitors as small as 0201 case size.

### Enable and Soft-Start

When EN is LOW, all circuits are off and the IC draws <550 nA of current. The EN pin does not have an internal pull-down resistor and must not be left floating. When EN is HIGH and V<sub>IN</sub> is above the UVLO threshold, the regulator begins a soft-start cycle for the output. The soft-start cycle controls inrush current, limiting it to the I<sub>LIM</sub> peak current limit.

### Short-Circuit and Thermal Protection

The output current is short-circuit protected. When an output fault occurs, the output current is automatically limited to I<sub>LIM</sub> and V<sub>OUT</sub> drops. The resultant V<sub>OUT</sub> is equal to I<sub>LIM</sub> multiplied by the fault impedance.

Short-circuit fault or output overload may cause the die temperature to increase and exceed the maximum rating due to power dissipation. In such cases (depending upon the ambient temperature; the V<sub>IN</sub>, load current, and thermal resistance (θ<sub>JB</sub>) of the mounted die), the device may enter thermal shutdown.

If the die temperature exceeds the thermal shutdown temperature threshold, the onboard thermal protection disables the output until the temperature drops below its hysteresis value. At that point, the output is re-enabled and a new soft-start sequence occurs.

### Thermal Considerations

For best performance, the die temperature and the power dissipated should be kept at moderate values. The maximum power dissipated can be evaluated based on the following relationship:

$$P_{D(max)} = \left\{ \frac{T_{J(max)} - T_A}{\theta_{JA}} \right\} \quad (1)$$

where T<sub>J(max)</sub> is the maximum allowable junction temperature of the die; T<sub>A</sub> is the ambient operating temperature; and θ<sub>JA</sub> is dependent on the surrounding PCB layout and can be improved by providing a heat sink of surrounding copper ground.

The addition of backside copper with through-holes, stiffeners, and other enhancements can help reduce θ<sub>JA</sub>. The heat contributed by the dissipation of devices nearby must be included in design considerations.

## Capacitor Selection

An output capacitor with an effective capacitance between 400 nF and 15 μF is required for loop stability. The ESR value should be within 3 to 100 mΩ. DC bias characteristics of the capacitors must be considered when selecting the voltage rating and the case size of the capacitor. Figure 16 is a typical derating curve for a 0201 case size, 1.5 μF, 6.3 V, X5R capacitor.

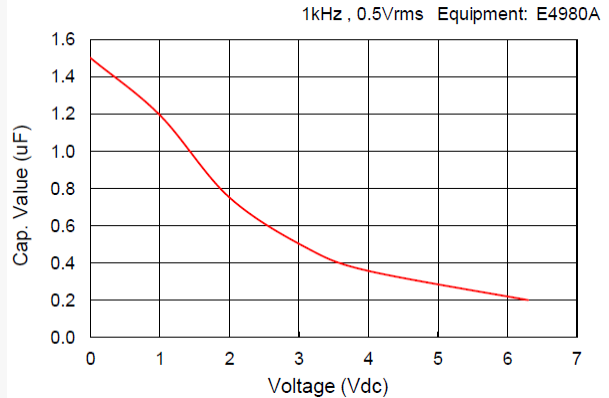


Figure 16. Capacitor DC Bias Characteristics

## PCB Layout Recommendations

Capacitors should be placed as close to the IC as possible. All power and ground pins should be routed to their capacitors using top copper. The copper area connecting to the IC should be maximized to improve thermal performance.

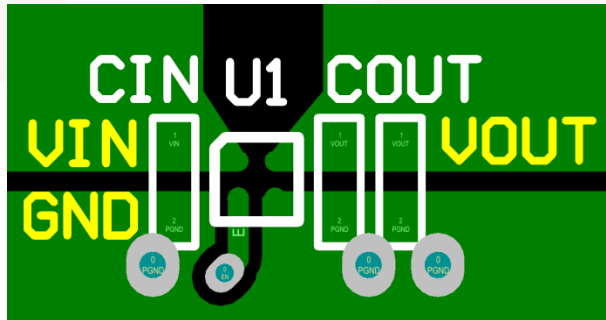
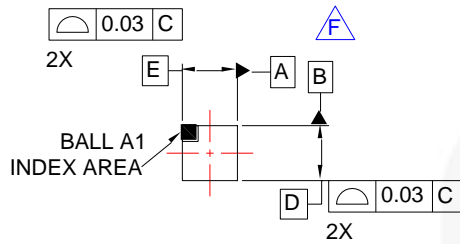
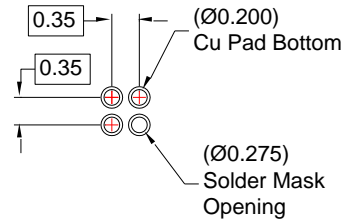


Figure 17. Recommended Layout

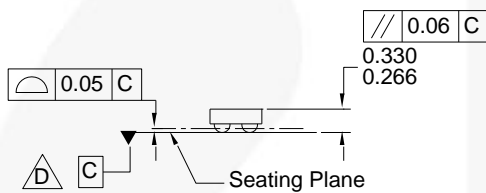
### Physical Dimensions



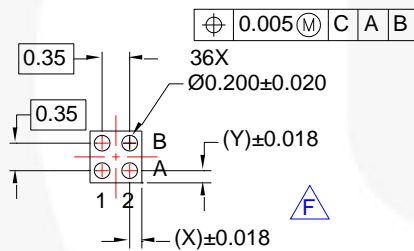
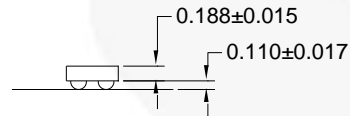
TOP VIEW



RECOMMENDED LAND PATTERN  
(NSMD 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. PACKAGE NOMINAL HEIGHT IS 298 ± 32 MICRONS (266-330 MICRONS).
- F. FOR DIMENSIONS D, E, X, AND Y SEE PRODUCT DATASHEET.
- G. DRAWING FILNAME: MKT-UC004AK REV1

Figure 17. 4-Ball, Wafer-Level, Chip-Scale Package (WLCSP), 0.35 mm Pitch

### Product-Specific Dimensions

D	E	X	Y
0.65 ±0.025 mm	0.65 ±0.025 mm	0.15 mm	0.15 mm

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| AX-CAP <sup>SM</sup> *               | FRFET <sup>®</sup>                             | PowerTrench <sup>®</sup>              | TinyBoost <sup>®</sup>     |
| BitSiC™                              | Global Power Resource <sup>SM</sup>            | PowerXS™                              | TinyBuck <sup>®</sup>      |
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| CROSSVOLT™                           | Gmax™  | Quiet Series™                         | TinyPower™                 |
| CTL™                                 | GTO™   | RapidConfigure™                       | TinyPVM™                   |
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| EcoSPARK <sup>®</sup>                | MegaBuck™                                      | SmartMax™                             | TRUECURRENT <sup>®</sup> * |
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| ESBC™                                | MicroFET™                                      | Solutions for Your Success™           |                            |
|                                      | MicroPak™                                      | SPM <sup>®</sup>                      | UHC <sup>®</sup>           |
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| Fairchild Semiconductor <sup>®</sup> | MillerDrive™                                   | SuperFET <sup>®</sup>                 | UniFET™                    |
| FACT Quiet Series™                   | MotionMax™                                     | SuperSOT™-3                           | VCX™                       |
| FACT <sup>®</sup>                    | mWSaver <sup>®</sup>                           | SuperSOT™-6                           | VisualMax™                 |
| FAST <sup>®</sup>                    | OptoHiT™                                       | SuperSOT™-8                           | VoltagePlus™               |
| FastvCore™                           | OPTOLOGIC <sup>®</sup>                         | SupreMOS <sup>®</sup>                 | XS™                        |
| FETBench™                            | OPTOPLANAR <sup>®</sup>                        | SyncFET™                              | 仙童™                        |
| FPS™                                 |  | Sync-Lock™                            |                            |

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**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. I68