

# FAN5400 Family USB-Compliant Single-Cell Li-Ion Switching Charger with USB-OTG Boost Regulator

## Features

- Fully Integrated, High-Efficiency Charger for Single-Cell Li-Ion and Li-Polymer Battery Packs
- Faster Charging than Linear
- Charge Voltage Accuracy:  $\pm 0.5\%$  at  $25^{\circ}\text{C}$   
 $\pm 1\%$  from  $0$  to  $125^{\circ}\text{C}$
- $\pm 5\%$  Input Current Regulation Accuracy
- $\pm 5\%$  Charge Current Regulation Accuracy
- 20V Absolute Maximum Input Voltage
- 6V Maximum Input Operating Voltage
- 1.25A Maximum Charge Rate
- Programmable through High-Speed I<sup>2</sup>C Interface (3.4Mb/s) with Fast Mode Plus Compatibility
  - Input Current
  - Fast-Charge / Termination Current
  - Charger Voltage
  - Termination Enable
- 3MHz Synchronous Buck PWM Controller with Wide Duty Cycle Range
- Small Footprint 1 $\mu\text{H}$  External Inductor
- Safety Timer with Reset Control
- 1.8V Regulated Output from VBUS for Auxiliary Circuits
- Weak Input Sources Accommodated by Reducing Charging Current to Maintain Minimum VBUS Voltage
- Low Reverse Leakage to Prevent Battery Drain to VBUS
- 5V, 300mA Boost Mode for USB OTG for 2.5 to 4.5V Battery Input

## Applications

- Cell Phones, Smart Phones, PDAs
- Tablet, Portable Media Players
- Gaming Device, Digital Cameras

## Description

The FAN5400 family (FAN540X) combines a highly integrated switch-mode charger, to minimize single-cell Lithium-ion (Li-ion) charging time from a USB power source, and a boost regulator to power a USB peripheral from the battery.

The charging parameters and operating modes are programmable through an I<sup>2</sup>C Interface that operates up to 3.4Mbps. The charger and boost regulator circuits switch at 3MHz to minimize the size of external passive components.

The FAN540X provides battery charging in three phases: conditioning, constant current, and constant voltage.

To ensure USB compliance and minimize charging time, the input current is limited to the value set through the I<sup>2</sup>C host. Charge termination is determined by a programmable minimum current level. A safety timer with reset control provides a safety backup for the I<sup>2</sup>C host.

The integrated circuit (IC) automatically restarts the charge cycle when the battery falls below an internal threshold. If the input source is removed, the IC enters a high-impedance mode with leakage from the battery to the input prevented. Charge status is reported back to the host through the I<sup>2</sup>C port. Charge current is reduced when the die temperature reaches  $120^{\circ}\text{C}$ .

The FAN540X can operate as a boost regulator on command from the system. The boost regulator includes a soft-start that limits inrush current from the battery.

The FAN540X is available in a 1.96 x 1.87mm, 20-bump, 0.4mm pitch WLCSP package.

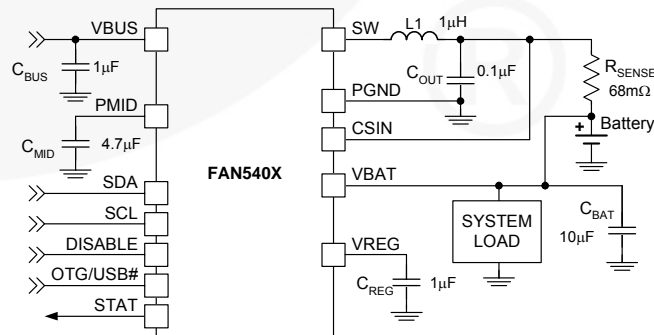


Figure 1. Typical Application (FAN5403-05 Pinout)

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## Ordering Information

Part Number	Temperature Range	Package	PN Bits: IC_INFO[4:3]	Packing Method
FAN5400UCX	-40 to 85°C	20- Bump, Wafer-Level Chip-Scale Package (WLCSP), 0.4mm Pitch, Estimated Size: 1.96 x 1.87mm	01	Tape and Reel
FAN5401UCX	-40 to 85°C		00	Tape and Reel
FAN5402UCX	-40 to 85°C		01	Tape and Reel
FAN5403UCX	-40 to 85°C		10	Tape and Reel
FAN5404UCX	-40 to 85°C		11	Tape and Reel
FAN5405UCX	-40 to 85°C		10	Tape and Reel

**Table 1. Feature Comparison Summary**

Part Number	PN Bits: REG3[4:3]	Slave Address	Automatic Charge	Special Charger <sup>(1)</sup>	Safety Limits	Battery Absent Behavior	E2 Pin	VREG (E3 Pin)
FAN5400	01	1101011	Yes	No	No	OFF	AUXPWR (Connect to VBAT)	PMID
FAN5401	00	1101011	No	No	No	OFF		
FAN5402	01	1101011	Yes	No	No	ON		
FAN5403	10	1101011	Yes	Yes	Yes	OFF	DISABLE	1.8V
FAN5404	11	1101011	No	Yes	Yes	OFF		
FAN5405	10	1101010	Yes	Yes	Yes	ON		

**Note:**

1. Special charger is a current limited charger that is not a USB compliant source.

**Table 2. Recommended External Components**

Component	Description	Vendor	Parameter	Typ.	Unit
L1	1μH, 20%, 1.3A, 2016	Murata: LQM2MPN1R0M or Equivalent	L	1.0	μH
			DCR (Series R)	85	mΩ
C <sub>BAT</sub>	10μF, 20%, 6.3V, X5R, 0603	Murata: GRM188R60J106M TDK: C1608X5R0J106M	C	10	μF
C <sub>MID</sub>	4.7μF, 10%, 6.3V, X5R, 0603	Murata: GRM188R60J475K TDK: C1608X5R0J475K	C <sup>(2)</sup>	4.7	μF
C <sub>BUS</sub>	1.0μF, 10%, 25V, X5R, 0603	Murata GRM188R61E105K TDK: C1608X5R1E105M	C	1.0	μF

**Note:**

2. 6.3V rating is sufficient for C<sub>MID</sub> since PMID is protected from over-voltage surges on VBUS by Q3 (Figure 3).

## Block Diagram

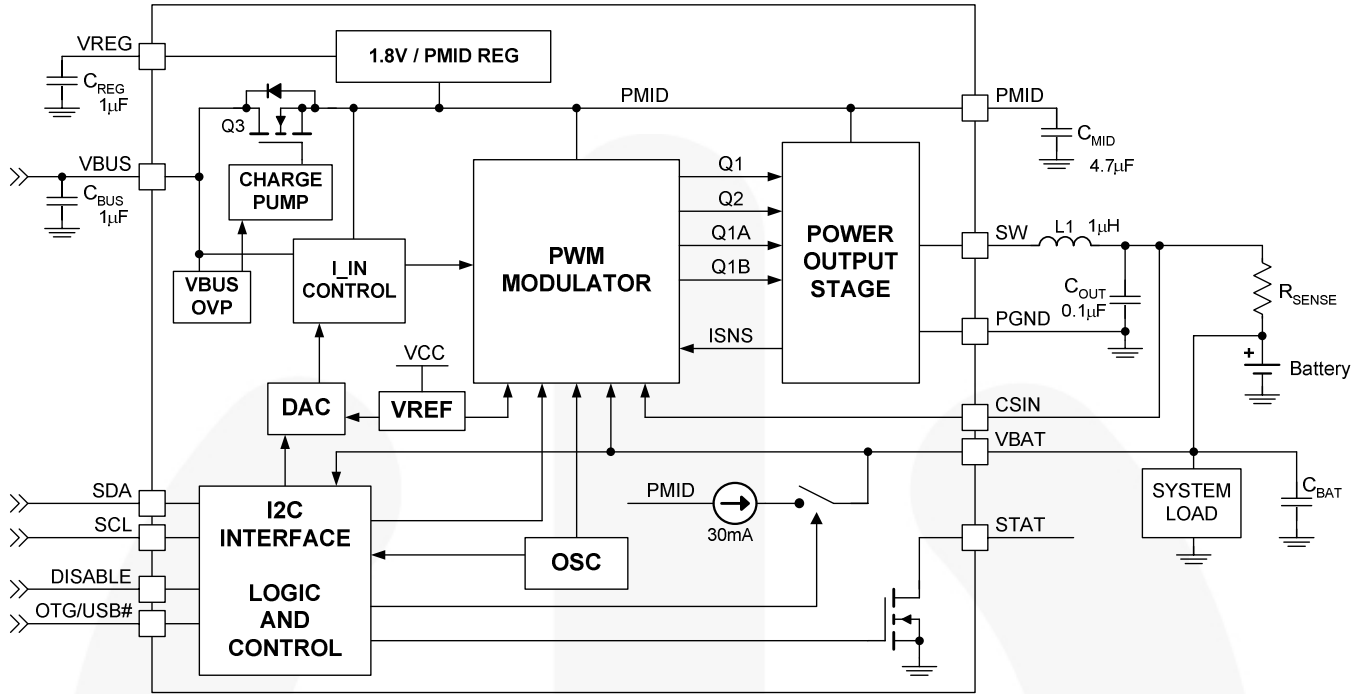


Figure 2. IC and System Block Diagram

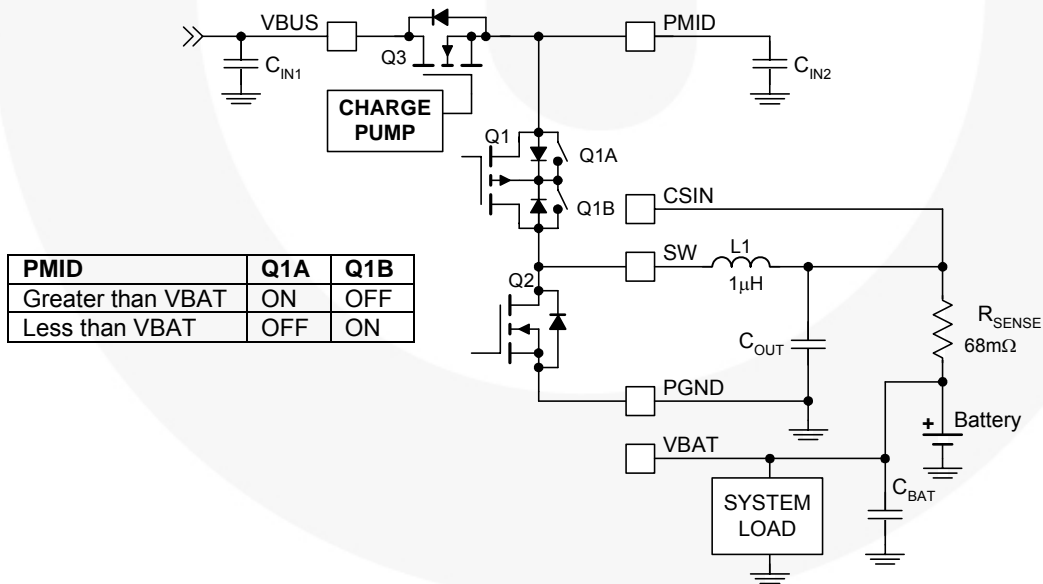


Figure 3. Power Stage

## Physical Dimensions

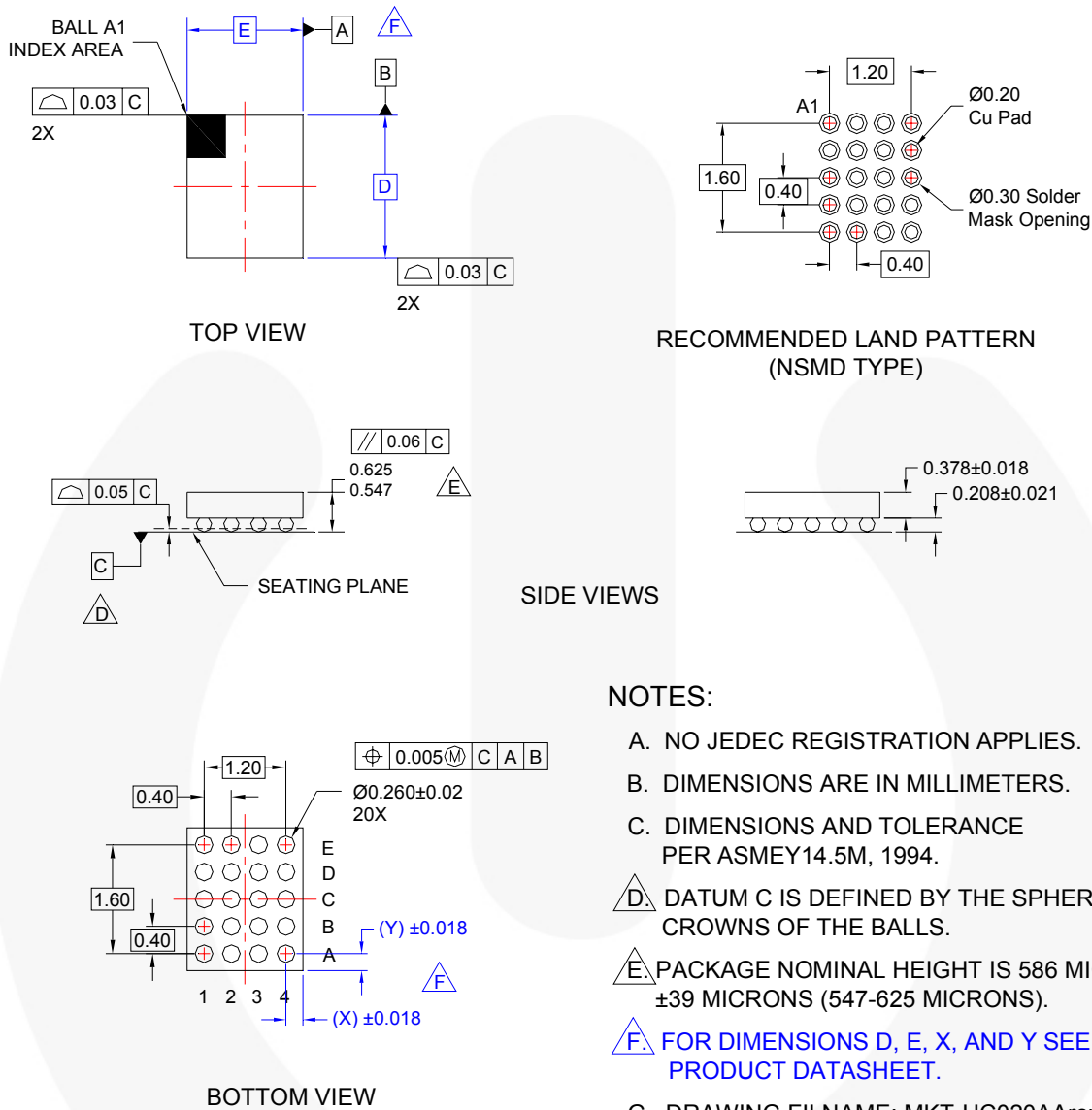


Figure 51. 20-Ball WLCSP, 4X5 Array, 0.4mm Pitch, 250µm Ball

## Product-Specific Dimensions

Product	D	E	X	Y
FAN540XUCX	1.960 $\pm 0.030$	1.870 $\pm 0.030$	0.180	0.335

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