

# FAN65004C-GEVB

## High Performance 65 V, 6 A Voltage Mode Synchronous PWM Buck Regulator Evaluation Board User's Manual

### Description

FAN65004C is a wide VIN highly efficient synchronous buck regulator, with integrated high side and low side power MOSFETs. The device incorporates a fixed frequency voltage mode PWM controller supporting a wide voltage range from 4.5 V to 65 V and can handle continuous currents up to 6 A.

FAN65004C includes a 0.67% accurate reference voltage to achieve tight regulation. The switching frequency can be programmed from 100 kHz to 1 MHz. To improve efficiency at light load condition, the device can be set to discontinuous conduction mode with pulse skipping operation.

FAN65004C has dual LDOs to minimize power loss and integrated current sense circuit that provides cycle-by-cycle current limiting. This single phase buck regulator offers complete protection features including Over current protection, Thermal shutdown, Under-voltage lockout, Over voltage protection, Under voltage protection and Short-circuit protection.

FAN65004C uses ON Semiconductor's high performance POWERTRENCH<sup>®</sup> MOSFETs that reduces ringing in switching applications. FAN65004C integrates the controller, driver, and power MOSFETs into a thermally enhanced, compact 6 × 6 mm PQFN package. With an integrated approach, the complete DC/DC converter is optimized from the controller and driver to MOSFET switching performance, delivering a high power density solution.

### Performance Specifications of the FAN65004C-GEVB

Parameter	Conditions	Performance Value
Input Voltage	Range 4.5 V to 65 V	48 V
Output Current		6 A
Output Voltage	13.4 V, 17 V, 28 V and 30.5 V	28 V
Output Voltage Ripple		20 mVp-p
Transient Response	Peak Deviation Load step 3 A/μs to 6 A/μs	1.1 V
Switching Frequency	100 kHz – 1 MHz	300 kHz
Efficiency		97.7%



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### EVAL BOARD USER'S MANUAL

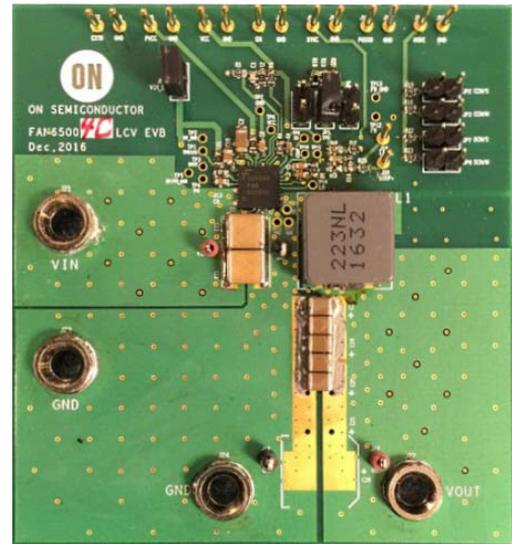


Figure 1. FAN65004C Evaluation Board



Figure 2. FAN65004C Efficiency

## FAN65004C-GEVB

The FAN65004C-GEVB has a simple layout and allows access to the appropriate signals through test points. To evaluate the performance, follow the procedure below and refer to Figure 3.

1. Connect a power supply to the input terminals  $V_{IN}$  and GND. Set  $V_{in}$  between 35 V to 60 V.
2. Connect the positive terminal of the electronic load to  $V_{OUT}$  and negative terminal to GND.
3. There are 2 ways to enable the device:
  - a. Use external voltage source of 2 V~5 V regardless of input voltage range, on the EN pin.
  - b. Use  $V_{IN}$  voltage divider. If so, 2 requirements need to be satisfied: J1 jumper be connected,  $V_{IN} \geq V_{IN\_UVLO}$ .
4. The evaluation board should now power up with a 13.4 V output voltage.
5. Check for the proper output voltage of 13.4 V ( $\pm 1\%$ ) at the output terminals  $V_{OUT}$  and GND. Measurement can also be done with a multimeter with the positive and negative leads between  $V_{OUT}$  and GND.
6. Set the load to 6 A through the electronic load. Check for the stable operation of the PH (TP16) signal on the oscilloscope. Measure the switching frequency. A test point is conveniently located at the head of the inductor.

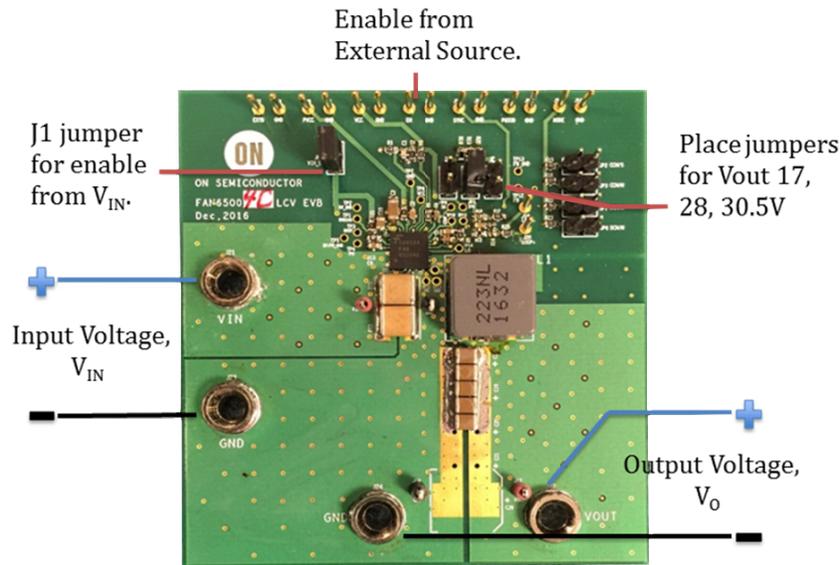


Figure 3. EVM Board Connections

### Measurement/Performance Guidelines:

1. The evaluation board has an easy access to measure AC analysis, if required. Connect the injection signal across the resistor (R25) as shown and measure AC analysis through a network analyzer.
2. When measuring the output voltage ripple, maintain the shortest possible ground lengths on the oscilloscope probe. Long ground leads can erroneously inject high frequency noise into the measured ripple.
3. For efficiency measurements, connect an ammeter in series with the input supply to measure the input current. Connect an electronic load to the output for output current



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## TYPICAL PERFORMANCE CHARACTERISTICS

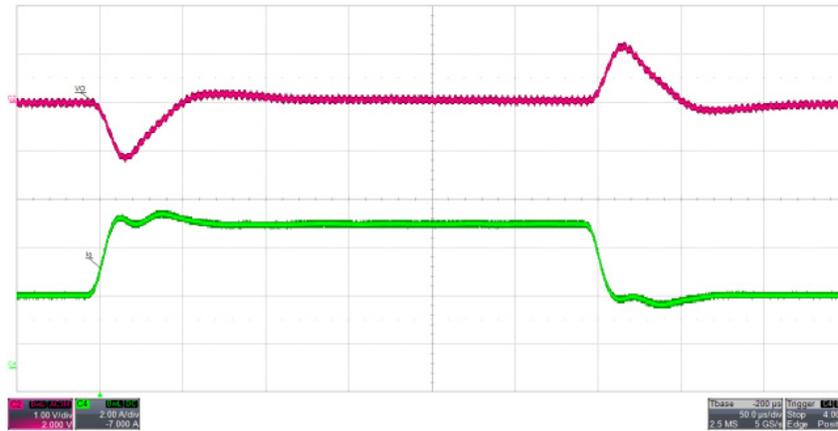


Figure 4. Load Step between 50% and 100% Load

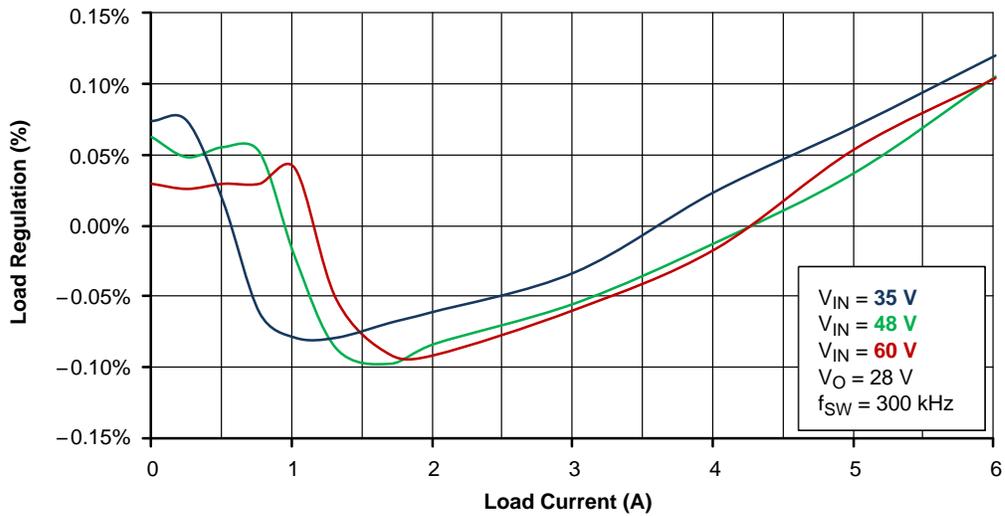


Figure 5. Load Regulation

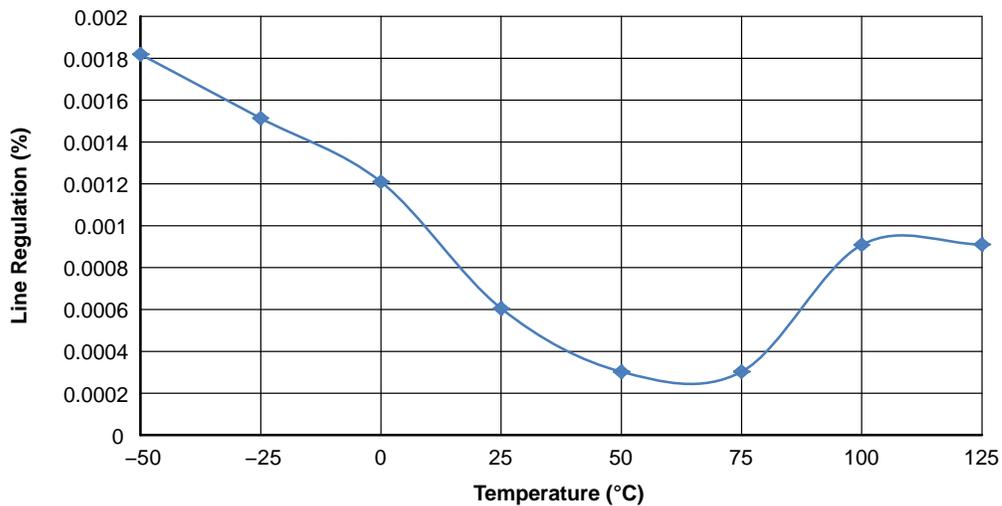
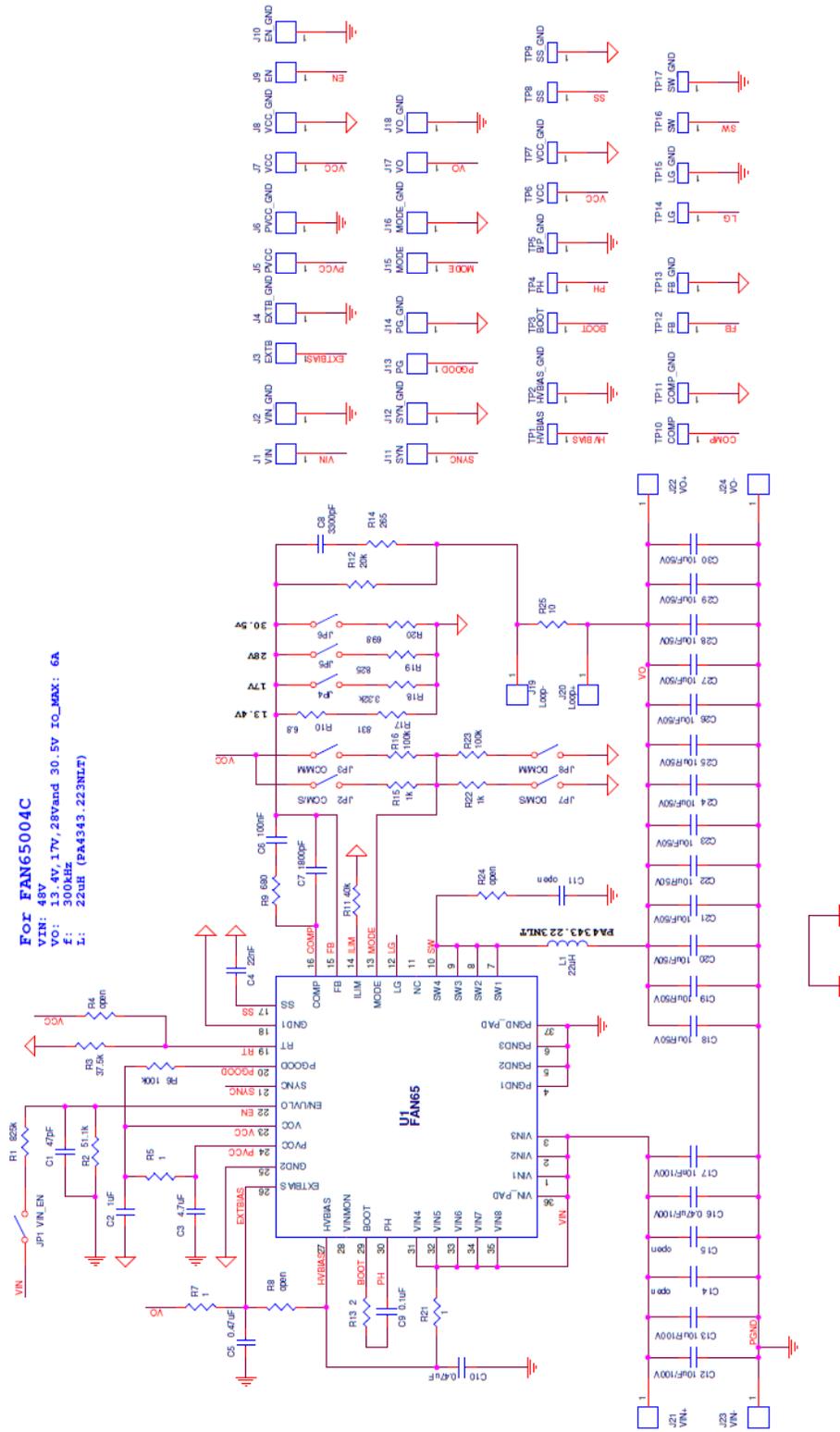


Figure 6. Line Regulation vs. Temperature

# FAN65004C-GEVB

## SCHEMATIC



# FAN65004C-GEVB

## PCB LAYERS

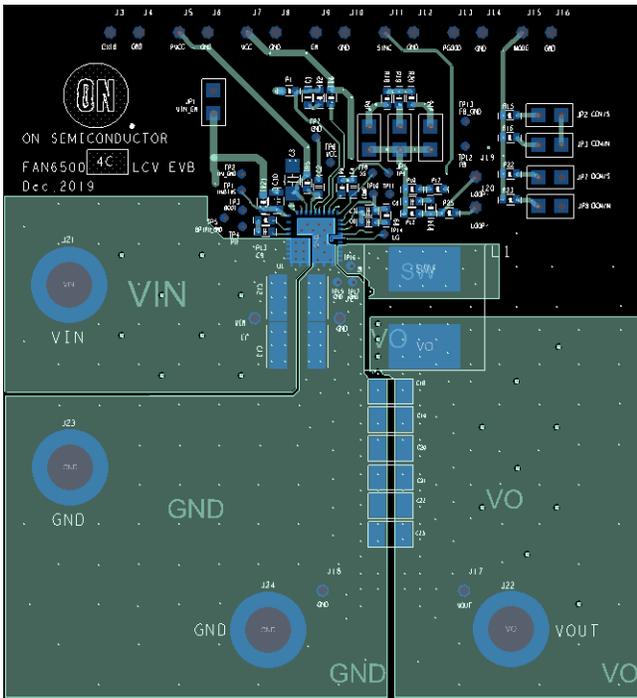


Figure 8. Top Layer

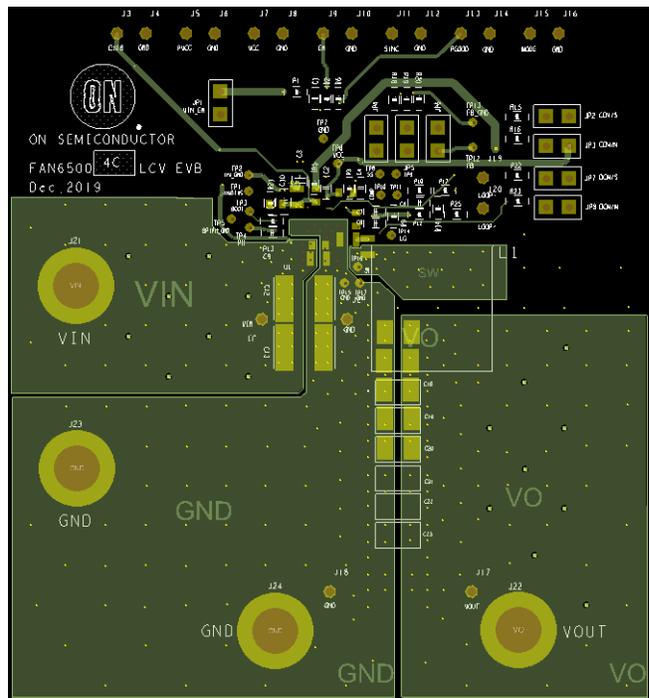


Figure 9. Bottom Layer

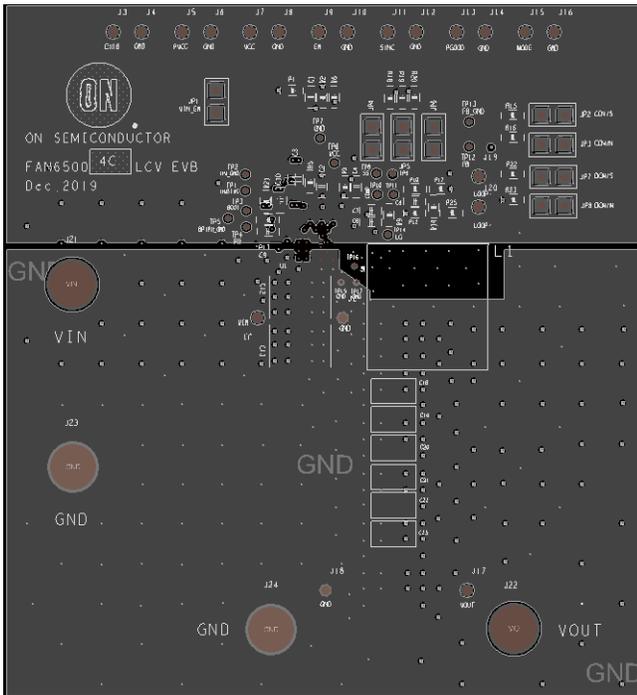


Figure 10. Inner Layer 1

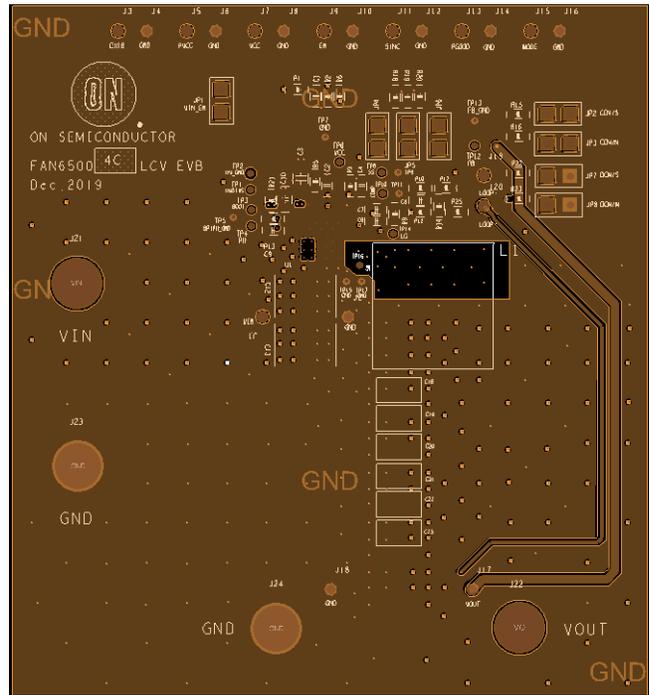


Figure 11. Inner Layer 2

# FAN65004C-GEVB

## BILL OF MATERIALS

**Table 1. BILL OF MATERIALS**

Item	Qty	Reference	Value	Voltage	PCB Footprint	Manufacturer Part Number	TC	Manufacturer
1	1	C1	47pF	50V	603	06035C470JAT2A	X7R	AVX
2	1	C2	1uF	10V	603	GRM188R71A105KA61D	X7R	Murata
3	1	C3	4.7uF	10V	612	GRM31CR71A475KA01L	X7R	Murata
4	1	C4	22nF	10V	603	885012206016	X7R	Würth
5	3	C5,C10,C16	0.47uF	100V	805	GRM21BR72A474KA73L	X7R	Murata
6	2	C6,C9	100nF	25V	603	GRM188R71E104KA01D	X7R	Murata
7	1	C7	1.8nF	50V	603	GRM188R71H221KA01D	X7R	Murata
8	1	C8	3.3nF	50V	603	GRM188R71H682KA01D	X7R	Murata
9	1	C11	Open	100-200V	805		X7R	
10	4	C12,C13,C14,C15	10uF	100V	2220	22201C106MAT2A	X7R	AVX
11	1	C17	10nF	100V	603	C1608X7R2A103K080AA	X7R	TDK
12	10	C18,C19,C20, C21,C22,C23,C24, C25,C26,C27	10uF	50V	1210	UMK325AB7106KM-T	X7R	Taiyo Yuden
13	1	C28	Open	35V	0.406"L x 0.406"W	35SVPF120M	X7R	Panasonic
14	1	JP1	VIN_EN		0.1"(LS) x 2x0.04"Hole	87224-2		TE Connectivity
15	1	JP2	CCM/S		0.1"(LS) x 2x0.04"Hole	87224-2		TE Connectivity
16	1	JP3	CCM/M		0.1"(LS) x 2x0.04"Hole	87224-2		TE Connectivity
17	1	JP4	V2		0.1"(LS) x 2x0.04"Hole	87224-2		TE Connectivity
18	1	JP5	V3		0.1"(LS) x 2x0.04"Hole	87224-2		TE Connectivity
19	1	JP6	V4		0.1"(LS) x 2x0.04"Hole	87224-2		TE Connectivity
20	1	JP7	DCM/S		0.1"(LS) x 2x0.04"Hole	87224-2		TE Connectivity
21	1	JP8	DCM/M		0.1"(LS) x 2x0.04"Hole	87224-2		TE Connectivity
22	1	J1	VIN		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
23	1	J2	VIN_GND		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
24	1	J3	EXTB		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
25	1	J4	EXTB_GND		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
26	1	J5	PVCC		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
27	1	J6	PVCC_GND		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
28	1	J7	VCC		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
29	1	J8	VCC_GND		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
30	1	J9	EN		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
31	1	J10	EN_GND		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
32	1	J11	SYN		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
33	1	J12	SYN_GND		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
34	1	J13	PG		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
35	1	J14	PG_GND		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
36	1	J15	MODE		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
37	1	J16	MODE_GND		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
38	1	J17	VO		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
39	1	J18	VO_GND		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
40	1	J19	Loop-		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.

# FAN65004C-GEVB

**Table 1. BILL OF MATERIALS** (continued)

Item	Qty	Reference	Value	Voltage	PCB Footprint	Manufacturer Part Number	TC	Manufacturer
41	1	J20	Loop+		0.043"pin	3103-2-00-21-00-00-08-0		Mill-Max Manufacturing Corp.
42	1	J21	VIN+		DIA_5P8mm	575-4		Keystone
43	1	J22	VO+		DIA_5P8mm	575-4		Keystone
44	1	J23	VIN-		DIA_5P8mm	575-4		Keystone
45	1	J24	VO-		DIA_5P8mm	575-4		Keystone
46	1	L1	22uH		0.867"x0.748"	PA4343.223NLT		Pulse
47	1	R1	825k		603	RC0603FR-07825KL		Yageo
48	1	R2	51.1k		603	RC0603FR-0751K1L		Yageo
49	1	R3	37.5k		603	RC0603FR-0737K4L	<1%	Yageo
50	2	R4,R8	Open		603			
51	3	R5,R7,R21	1		603	RC0603FR-071RL		Yageo
52	3	R6,R16,R23	100k		603	RC0603FR-07100KL		Yageo
53	1	R9	680		603	RC0603FR-07680RL		Yageo
54	1	R10	6.8		603	RC0603FR-076R81L	<1%	Yageo
55	1	R11	40k		603	TNPW060340K0BEEA	<100ppm	Vishay
56	1	R12	20k		603	RC0603FR-0720KL	<1%	Yageo
57	1	R13	2		603	AC0603FR-072RL		Yageo
58	1	R14	280		603	RC0603FR-07280RL		Yageo
59	2	R15,R22	1k		603	RC0603FR-071KL		Yageo
60	1	R17	931		603	RC0603FR-07931RL	<1%	Yageo
61	1	R18	3.32k		603	RC0603FR-073K32L	<1%	Yageo
62	1	R19	825		603	RC0603FR-07825RL	<1%	Yageo
63	1	R20	698		603	RT0603BRD07690RL	<1%	Yageo
64	1	R24	Open		805		0.5W	
65	1	R25	10		603	RC0603FR-0710RL		Yageo
66	1	TP1	HVBIAS		0.8mm-Hole			
67	1	TP2	HVBIAS_GND		0.8mm-Hole			
68	1	TP3	BOOT		0.8mm-Hole			
69	1	TP4	PH		0.8mm-Hole			
70	1	TP5	B/P_GND		0.8mm-Hole			
71	1	TP6	VCC		0.8mm-Hole			
72	1	TP7	VCC_GND		0.8mm-Hole			
73	1	TP8	SS		0.8mm-Hole			
74	1	TP9	SS_GND		0.8mm-Hole			
75	1	TP10	COMP		0.8mm-Hole			
76	1	TP11	COMP_GND		0.8mm-Hole			
77	1	TP12	FB		0.8mm-Hole			
78	1	TP13	FB_GND		0.8mm-Hole			
79	1	TP14	LG		0.8mm-Hole			
80	1	TP15	LG_GND		0.8mm-Hole			
81	1	TP16	SW		0.8mm-Hole			
82	1	TP17	SW_GND		0.8mm-Hole			
83	1	U1	FAN65004C	65V	MLP6x6	FAN65		ON Semiconductor

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