A5947-B

Three-Phase Sensorless Fan Driver IC

FEATURES AND BENEFITS

- AEC-Q100 qualified
- Speed curve configuration via EEPROM
- I^2C serial port
- Sinusoidal modulation for reduced audible noise and low vibration
- Sensorless (no Hall sensors required)
- Low $R_{DS(ON)}$ power MOSFETs
- 3.3 V / 20 mA linear regulator
- PWM or analog speed input
- FG speed output
- Slew rate control
- Lock detection
- Soft start
- Low power standby mode
- Overcurrent protection
- Overvoltage protection

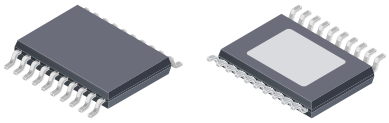
DESCRIPTION

The A5947-B three phase motor driver IC incorporates sensorless sinusoidal drive to minimize vibration for a wide variety of fan applications. Sensorless control eliminates the requirement for Hall sensors.

A flexible closed-loop speed control system is integrated into the IC. EEPROM is used to tailor the common functions of the fan speed curve to a specific application. This eliminates the requirement for a microprocessor-based system and minimizes programming requirements.

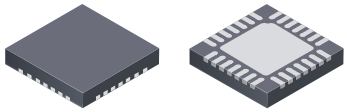
The A5947-B is available in a 28-contact 5 mm × 5 mm QFN with exposed thermal pad (suffix ET) and a 20-lead TSSOP with exposed thermal pad (suffix LP).

PACKAGES:



20-lead TSSOP
with exposed thermal pad
(LP package)

Not to scale



28-contact QFN
with exposed thermal pad
5 mm × 5 mm × 0.90 mm
(ET package)

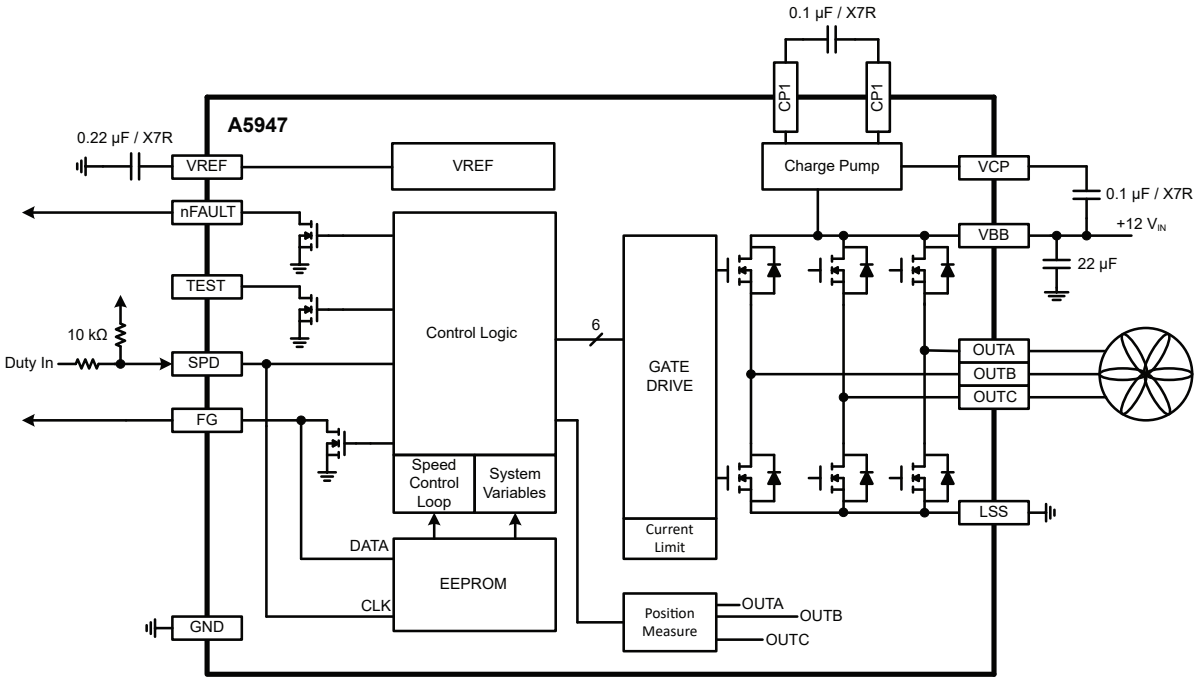


Figure 1: Typical Application

SELECTION GUIDE

Part Number	Operating Temperature Range (T_A) (°C)	Packaging	Packing
A5947KLPTR-B-T	–40 to 125	20-lead TSSOP with exposed power pad	4000 pieces per 13-inch reel

ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Notes	Rating	Unit
Supply Voltage	V_{BB}		–0.7 to 40	V
Logic Input Voltage Range	V_{IN}	SPD	–0.3 to 6	V
Logic Output	V_O	FG, nFAULT, TEST	–0.3 to 6	V
Output Current	I_{OUT}		3.6	A
Output Voltage	V_{OUT}	OUTA, OUTB, OUTC	V_{BB} + 1	V
VCP	V_{CP}		V_{BB} – 0.3 to V_{BB} + 8	V
CP1	V_{CP1}		–0.3 to V_{BB} + 0.3	V
CP2	V_{CP2}		V_{BB} – 0.3 to V_{CP} + 0.3	V
Maximum EEPROM write cycles	$EEPROM_{W(MAX)}$		1000	cycles
Junction Temperature	T_J		150	°C
Storage Temperature Range	T_{stg}		–55 to 150	°C
Operating Temperature Range	T_A	Range G	–40 to 105	°C
		Range K	–40 to 125	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Test Conditions*	Value	Unit
Package Thermal Resistance	$R_{\theta JA}$	28-contact QFN (package ET), on 2-sided PCB 1-in.^{2} copper	40	°C/W
		20-lead TSSOP (package LP), on 2-sided PCB 1-in.^{2} copper	34	°C/W

*Additional thermal information available on the Allegro website.

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955 Perimeter Road
Manchester, NH 03103-3353 U.S.A.
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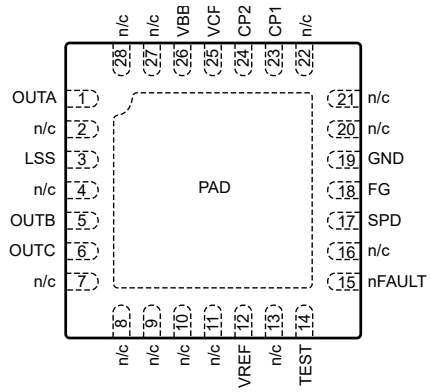
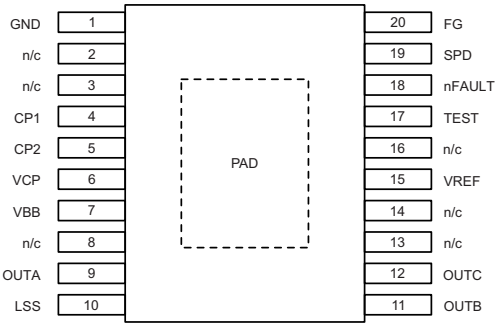
PINOUT DIAGRAMS AND TERMINAL LIST TABLE



ET Package Pinouts



LP Package Pinouts

Terminal List Table

Terminal Number		Name	Function
ET Package	LP Package		
19	1	GND	Ground
20,21,22	2,3	n/c	No connect
23	4	CP1	Charge pump capacitor
24	5	CP2	Charge pump capacitor
25	6	VCP	Charge pump capacitor
26	7	VBB	Input supply
27,28	8	n/c	No connect
1	9	OUTA	Motor terminal
2		n/c	No connect
3	10	LSS	Low side source connection
4		n/c	No connect
5	11	OUTB	Motor terminal
6	12	OUTC	Motor terminal
7,8,9,10,11	13,14	n/c	No connect
12	15	VREF	Reference voltage output
13	16	n/c	No connect
14	17	TEST	Logic output signal
15	18	nFAULT	Logic output signal
16		n/c	No connect
17	19	SPD	Logic input – speed demand
18	20	FG	Logic output signal
–	–	PAD	Exposed pad for enhanced thermal dissipation

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ELECTRICAL CHARACTERISTICS [1]: Valid for T_A = 25°C (G version) or T_A = –40°C to 125°C (K version); V_{BB} = 4 to 40 V, unless noted otherwise

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
GENERAL						
VBB Supply Current	I_{BB}	Active mode (PWM duty < DC_ON)	–	13.5	15	mA
	I_{BBS}	V_{BB} = 34 V, standby mode	–	10	40	µA
Reference Voltage	V_{REF}	I = 0 to 20 mA, V_{BB} = 6 to 40 V	3.15	3.3	3.45	V
Charge Pump	V_{CP}	Relative to V_{BB}, V_{BB} = 8 V	6.5	7.2	7.7	V
		Relative to V_{BB}, V_{BB} = 4 V	3.5	3.7	–	V
POWER DRIVER						
Total Driver On-Resistance (Sink + Source)	$R_{DS(ON)}$	I = 1.5 A, T_J = 25°C, V_{BB} = 12 V	–	510	–	mΩ
		I = 1.5 A, T_J = 125°C, V_{BB} = 12 V	–	760	860	mΩ
		I = 1.5 A, T_J = 25°C, V_{BB} = 4 V	–	680	–	mΩ
		I = 1.5 A, T_J = 125°C, V_{BB} = 4 V	–	950	1200	mΩ
Source Driver On-Resistance	$R_{DS(ON)SRC}$	T_J = 125°C, V_{BB} = 12 V	–	380	–	mΩ
Sink Driver On-Resistance	$R_{DS(ON)SNK}$	T_J = 125°C, V_{BB} = 12 V	–	380	–	mΩ
Motor PWM Frequency	f_{PWM}	T_A = 25°C	23.52	24.5	25.48	kHz
		T_A = –40°C to 125°C	23.03	–	25.97	kHz
SPEED CONTROL						
PWM Input Frequency Range	f_{PWMIN}		34	–	65000	Hz
Duty Cycle On Threshold	DC_{ON}	Relative to target	–0.5	–	0.5	%
Duty Cycle Off Threshold	DC_{OFF}	Relative to target	–0.5	–	0.5	%
SPD Standby Threshold (Analog)	V_{SPDTH}		0.43	0.7	1	V
SPD On Threshold	V_{SPDON}	DC_{ON} = 10%	210	240	270	mV
SPD Off Threshold	V_{SPDOFF}	DC_{OFF} = 8%	160	190	220	mV
SPD Max	V_{SPDMAX}		–	2.49	–	V
SPD ADC Resolution	V_{SPDLSB}		–	4.892	–	mV
SPD ADC Accuracy	SPD_{ACC}	V_{BB} = 12 V, V_{SPD} = 0.2 V to V_{SPDMAX}	–10	–	10	LSB
Speed Setpoint	f_{SPD}	Duty cycle input; T_A = 25°C	–5	–	5	%
		Duty cycle input; T_A = –40°C to 125°C	–7	–	7	%

[1] Specified limits are tested at a single temperature and assured over temperature range by design and characterization.

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ELECTRICAL CHARACTERISTICS [1] (continued): Valid for T_A = 25°C (G version) or T_A = –40°C to 125°C (K version); V_{BB} = 4 to 40 V, unless noted otherwise

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
PROTECTION CIRCUITS						
Lock Timing	t_{LOCK}	Relative to target	–5	–	5	%
VBB Undervoltage Threshold	V_{BBUVLO}	UVLO = 0, V_{BB} rising	3.7	3.85	4	V
		UVLO = 1, V_{BB} rising	8.4	8.65	9.02	V
VBB Undervoltage Hysteresis	V_{BBHYS}	UVLO = 0	160	300	480	mV
		UVLO = 1	1.8	2	2.2	V
Overcurrent Limit	I_{OCL}	V_{BB} = 8 V	2.5	3	3.5	A
Overcurrent Protection	I_{OCP}		3.94	7	–	A
VBB Overvoltage	V_{BBOV}	VBBOV = 0, V_{BB} rising	18.2	19	19.8	V
		VBBOV = 1, V_{BB} rising	36.8	37.5	39.3	V
VBB Overvoltage Hystersis	$V_{BBOVHYS}$		1.5	2	2.5	V
VREF UVLO	$V_{REFUVLO}$	V_{REF} rising	2.9	3	3.15	V
VREF UVLO Hystersis	V_{REFHYS}		150	250	350	mV
VREF Overcurrent Limit	V_{REFOCL}	V_{BB} = 12 V	30	65	120	mA
VCP UVLO	V_{CPUVLO}	V_{CP} rising	2.5	2.75	3.0	V
VCP UVLO HYS	$V_{CPUVLOHYS}$		–	110	–	mV
Thermal Shutdown Temperature	T_{JTSD}	Temperature increasing	150	165	180	°C
Thermal Shutdown Hysteresis	ΔT_J	Recovery = $T_{JTSD} - \Delta T_J$	–	20	–	°C
LOGIC/INPUT OUTPUT/I²C						
Logic Input Current (SPD, FG)	I_{IN}	V_{IN} = 0 to 5.5 V	–5	<1	5	µA
Logic Input Low Level	V_{IL}		0	–	0.8	V
Logic Input High Level	V_{IH}		2	–	5.5	V
Logic Input Hysteresis	V_{HYS}		200	300	600	mV
Output Saturation Voltage (FG, RD)	V_{SAT}	I = 5 mA	–	–	0.3	V
Output Leakage	I_{OUT}	V = 5.5 V, switch OFF	–	–	5	µA
I²C TIMING						
SCL Clock Frequency	f_{CLK}		3	–	400	kHz
Bus Free-Time Between Stop/Start	t_{BUF}		1.3	–	–	µs
Hold Time Start Condition	$t_{HD:STA}$		0.6	–	–	µs
Setup Time for Start Condition	$t_{SU:STA}$		0.6	–	–	µs
SCL Low Time	t_{LOW}		1.3	–	–	µs
SCL High Time	t_{HIGH}		0.6	–	–	µs
Data Setup Time	$t_{SU:DAT}$		100	–	–	ns
Data Hold Time	$t_{HD:DAT}$		0	–	900	ns
Setup Time for Stop Condition	$t_{SU:STO}$		0.6	–	–	µs

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