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# STK984-091A-E

Thick-Film Hybrid IC

## 3-phase Brush-less DC Motor Driver IC

### Overview

The STK984-091A-E is a hybrid IC designed to be used in Brush-less DC Motor.

### Application

- Industrial – Motor Drive

### Features

- FET can be driven (built-in pre-driver IC) by microcontroller output ( logic system).
- Various protections (Overcurrent Protection, Over Temperature Protection, Low Voltage Protection, Over Voltage Protection) are incorporated.
- Intelligent DIAG Function that externally outputs each protection status, such as Overcurrent Protection, Over Temperature Protection.
- Protection functions can be reset by external inputs.

### Series model

	STK984-091A-E	STK984-090A-E
VB max	40V	40V
Id max	20A	20A
IOC	91-170A	68-160A
ISD	48-90A	22-65A
TSD	135-145°C	126-136°C

### Specifications

**Absolute Maximum Ratings** at Ta = 25°C, Tc = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V+B1	+B1 to PG	-0.3 to 40	V
	V+B2	+B2 to SG		
Control input voltage	V <sub>IN</sub> max	UT, VT, WT, UB, VB, WB to SG	-0.3 to 6	V
DIAG terminal voltage	VDIAG	DIAG1, DIAG2 to SG	-0.3 to 6	V
Drain current	Id max	DC	20	A
		Pulse (Single-Shot within 10μs)	180	A
Junction temperature	Tj max	Semiconductor device	150	°C
Storage temperature	Tstg		-40 to +125	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

### ORDERING INFORMATION

See detailed ordering and shipping information on page 7 of this data sheet.

**Recommended Operating Conditions** at  $-40^{\circ}\text{C} \leq T_c \leq 125^{\circ}\text{C}$

Parameter	Symbol	Test Conditions	min	typ	max	Unit
Supply voltage	V+B1	+B1 to PG	8	13.5	18	V
	V+B2	+B2 to SG				
Output current	$I_O$	$I_O \propto$ ON duty, ON duty100% 120deg excitation method			20	A
Operating substrate temperature	$T_c$	Thick film IC substrate temperature	-40		125	$^{\circ}\text{C}$
Drive PWM frequency	FO	ONDuty: 10 to 90%, 100%			20	kHz

**Thermal Resistance**

Parameter	Symbol	Test Conditions	min	typ	max	Unit
Chip-case resistance	$\theta_{jc}$	Junction -to- backside of the substrate MOSFET/ch		4.5		$^{\circ}\text{C/W}$

**Electrical Characteristics** at  $T_a = 25^{\circ}\text{C}$ , V+B1 (V+B2) = 13.5V unless otherwise specified

Parameter	Symbol	Test Conditions		min	typ	max	Unit
Current consumption (Control system)	$I_{CC}$	V+B1=V+B2=16V			10	15	mA
Output saturation voltage	$V_{DS}(\text{sat})$	$I_O=20\text{A}$	+B1 to U, V, W		0.3	0.5	V
			U, V, W to PG		0.2	0.4	
Current sensing resistor	$R_s$			2.91	3.00	3.09	m $\Omega$
Time delay (ON)	$t_d(\text{on})$	20A	U, V, W	0.9	1.8	2.8	$\mu\text{s}$
			U <sup>-</sup> , V <sup>-</sup> , W <sup>-</sup>	0.9	1.9	3.0	
Rise time	$t_r$	20A			0.3		$\mu\text{s}$
Time delay (OFF)	$t_d(\text{off})$	20A	U, V, W	1.3	2.9	4.5	$\mu\text{s}$
			U <sup>-</sup> , V <sup>-</sup> , W <sup>-</sup>	0.8	2.2	3.5	
Fall time	$t_f$	20A			0.3		$\mu\text{s}$

**Motor Control Input Terminal** at  $8\text{V} \leq V+B1 (V+B2) \leq 18\text{V}$ ,  $-40^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$

Parameter	Symbol	Test Conditions	min	typ	max	Unit
Input ON voltage	$V_{IN}(\text{on})$	Output on UT, VT, WT, UB, VB, WB to SG	3.5			V
Input OFF voltage	$V_{IN}(\text{off})$	Output off UT, VT, WT, UB, VB, WB to SG			1.5	V

**Reset Input Terminal** at  $8\text{V} \leq V+B1 (V+B2) \leq 18\text{V}$ ,  $-40^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$

Parameter	Symbol	Test Conditions	min	typ	max	Unit
Reset high voltage	$V_{\text{reset}}(\text{Hi})$	Output ON	3.5			V
Reset low voltage	$V_{\text{reset}}(\text{Lo})$	Output OFF			1.5	V
Output delay time (ON)	$t_{\text{reset}}(\text{on})$	From reset input terminal (RESET=Hi) to output ON		0.25		ms
Output delay time (OFF)	$t_{\text{reset}}(\text{off})$	From reset input terminal (RESET=Lo) to output OFF		2		$\mu\text{s}$

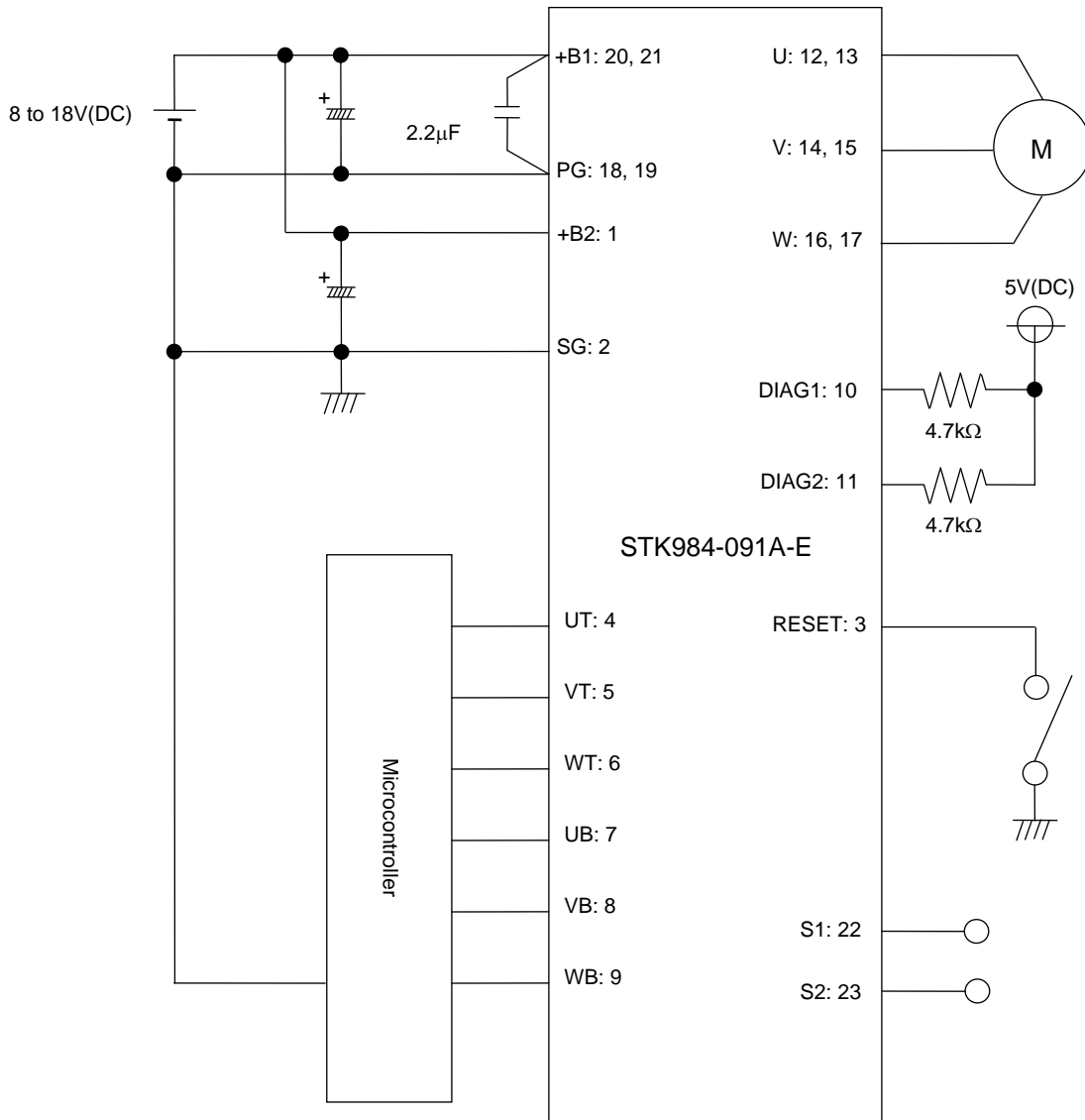
## STK984-091A-E

**Protective Function** at Ta = 25°C, V+B1 (V+B2) = 13.5V unless otherwise specified

Parameter	Symbol	Test Conditions	min	typ	max	Unit
Low voltage protection threshold	Vuv		4.45	4.75	5.1	V
Low voltage protection hysteresis	Vuv(hy)		0.07	0.2	0.3	V
Low voltage shutdown output delay	Tuvoff			1.0		μs
Over current threshold	ISD	Automatic recovery	48	68	90	A
Over current DIAG output delay time	Tocdgoff			4.3		μs
Over current shutdown interval	tint			1		ms
Over current shutdown output delay	Tocoff			4.3		μs
Ground fault short-circuit protection	IOC	Power-cycle	91	134	170	A
Ground fault short-circuit detection DIAG output delay time	Tspdgoff			3.0		ms
Ground fault short-circuit shutdown output delay time	Tspoff			3.0		ms
Temperature protection shutdown	Tst	Thick film IC substrate temperature, automatic restoration	135	140	145	°C
Temperature protection recovery	Tst(hy)	Thick film IC substrate temperature	115	120	125	°C
Over temperature DIAG output delay time	Tthdgoff			3.4		ms
Over temperature shutdown output delay	Tthoff			3.4		μs
Over voltage threshold	Vov		24			V
Over voltage protection hysteresis width	Vov(hy)			0.5		V
Over voltage shutdown output delay	Tovoff			1.0		μs



## Application Circuit



### NOTE

1. A voltage overshoot with vibration will be occurred during a switching operation due to floating inductance of the power source wiring connected between terminal +B1 and PG. In order that the voltage overshoot between +B1 and PG, +B1 and each -UBW, each UVW and PG will not exceed its rating, please minimize wiring inductance by shortening the wiring, also connect a snubber circuit close to between +B1 and PG terminals.
2. With the object of the overcurrent protection circuit fail-safe design, inserting a fuse in +B1 line is recommended.
3. There is a 100kΩ (Typ) pull-down resistor connected inside of the signal input terminal. However, in the case of mounting a resistor externally to reduce noise due to wiring, please satisfy the input voltage threshold of this Hybrid-IC.
4. Terminal DIAG 1 and DIAG 2 are the open drain output configuration. Please pull up with 4.7kΩ resistor to 5V power supply.
5. There is a 100kΩ (Typ) pull-up resistor connected inside of the RESET terminal. It operates normally in the open-state. When the short-circuit protection operates and latches the output OFF, the latched output OFF can be released by making RESET terminal Low and re-opened.

## STK984-091A-E

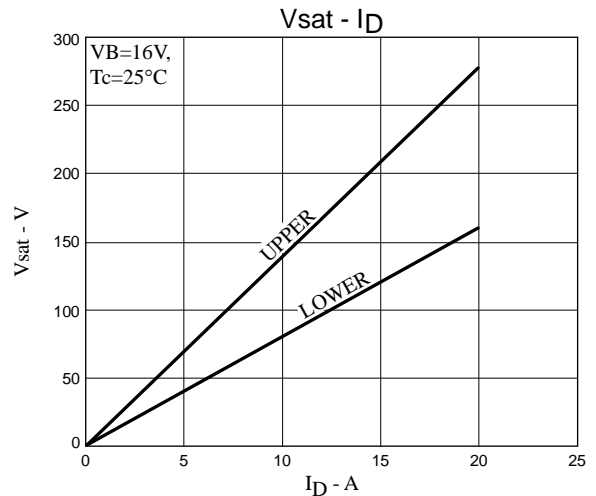
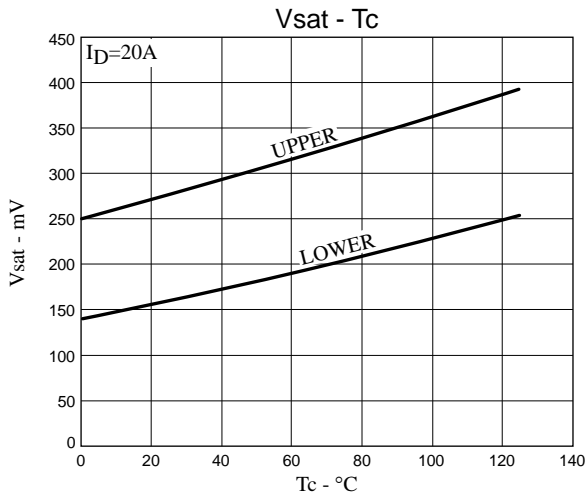
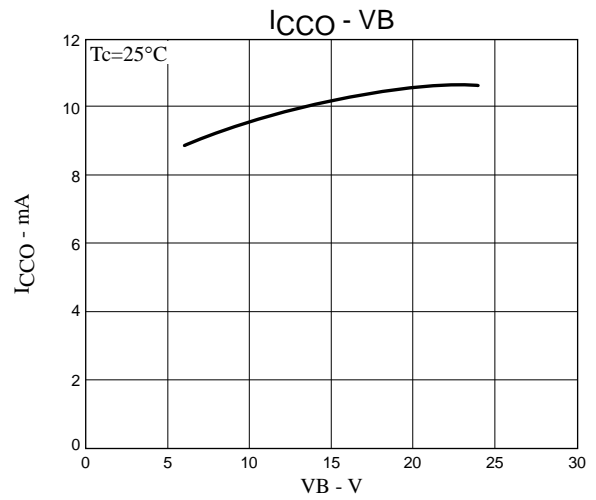
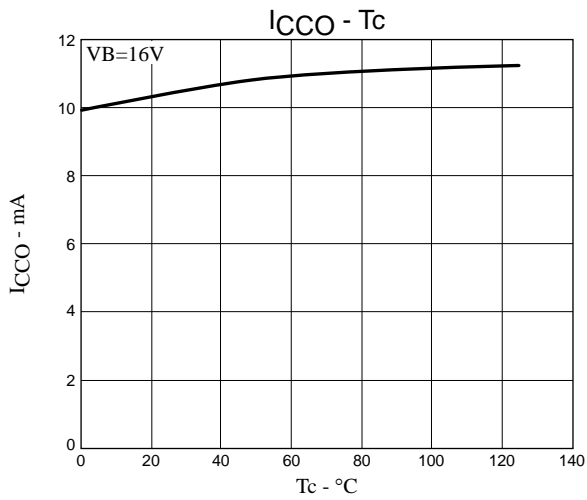
### Pin Function Description

Pin No.	Pin Name	Description	Pin*
1	+B2	Control System Power	S
2	SG	Control System GND	S
3	RESET	RESET Terminal Normal operating in RESET = H or Open-State The Gate Output will be Lo-state for both Hi/Lo sides with RESET = L (Output OFF) Output OFF Latch Release terminal of Short-circuit Protection	S
4	UT	Driving Signal Input Upper U-phase	S
5	VT	Driving Signal Input Upper V-phase	S
6	WT	Driving Signal Input Upper W-phase	S
7	UB	Driving Signal Input Lower U-phase	S
8	VB	Driving Signal Input Lower V-phase	S
9	WB	Driving Signal Input Lower W-phase	S
10	DIAG1	Fault Diagnosis Output 1 (Overcurrent) Normal Operation: Lo Abnormal Operation: Hi	S
11	DIAG2	Fault Diagnosis Output 2 (Over Temperature) Normal Operation: Lo Abnormal Operation: Hi	S
12	U	U-phase Output	P
13	U	U-phase Output	P
14	V	V-phase Output	P
15	V	V-phase Output	P
16	W	W-phase Output	P
17	W	W-phase Output	P
18	PG	Power System GND	P
19	PG	Power System GND	P
20	+B1	Power System Supply	P
21	+B1	Power System Supply	P
22	S1	Current Sense Resistor Sensing (+) terminal	S
23	S2	Current Sense Resistor Sensing (-) terminal	S

\*

S: Signal terminal

P: Power terminal



## ORDERING INFORMATION

Device	Package	Shipping (Qty / Packing)
STK984-091A-E	SIP-23 (Pb-Free)	9 / Fan-Fold

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