



SANYO Semiconductors

DATA SHEET

STK611-710-E — Thick-Film Hybrid IC 3-phase Fan-Motor Drive Inverter Hybrid IC

Overview

The STK611-710-E is an inverter power hybrid IC for use in 3-phase fan-motor applications and contains power stage, pre-driver, and protection circuits.

Applications

- 3-phase inverter motor drive for fans, refrigerators, etc.

Features

- Protective circuits including overcurrent (bus line), and pre-drive low voltage protection are built in.
- Direct input of CMOS level control signals without an insulating circuit is possible.(Hi Active).
- Single power supply drive is possible through the use of a built-in upper-side power-supply bootstrap circuit (Needs external capacitors).
- Built-in simultaneous upper/lower ON prevention circuit to prevent arm shorting through simultaneous ON input for the upper and lower side transistors. (Dead time is required for preventing shorting due to switching delay.)
- Overcurrent protection can be provided by adding an external shunt resistor.
- The built-in thermistor allows substrate temperature to be monitored.

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STK611-710-E

Specifications

Absolute Maximum Ratings at $T_c = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	unit
Supply voltage	V_{CC}	Between + and - terminals, surge voltage < 500V *1	400	V
Collector-emitter voltage	V_{CE}	Between + and U (V, W) terminals or U (V, W) and - terminals	500	V
Output current	I_O	+, -, U, V, W terminal current	± 1	A
Output peak current	I_{op}	+, -, U, V, W terminal current P.W. = 100 μ s	± 2	A
Pre-driver supply voltage	VD1, 2, 3, 4	VB1 - U, VB2 - V, VB3 - W, $V_{DD} - V_{SS}$ terminal *2	20	V
Input signal voltage	V_{IN}	HIN1, 2, 3, LIN1, 2, 3 terminal	0 to 15	V
FAULT/EN terminal voltage	VFAULT	FAULT/EN terminal	20	V
Maximum loss	P_d	MOSFET, Per 1 channel	11	W
Junction temperature	T_j	MOSFET junction temperature	150	$^\circ\text{C}$
Storage temperature	T_{stg}		-40 to +125	$^\circ\text{C}$
Operating temperature	T_c	H-IC case temperature	-20 to +100	$^\circ\text{C}$
Tightening torque	MT	A screw part *3	0.6	N•m

– V_{SS} terminal voltage is the reference voltage unless otherwise specified.

*1 Surge voltage developed by the switching operation due to the wiring inductance between the + and – terminals.

*2 VD1 means voltage between VB1 and U terminals, VD2 between VB2 and V, VD3 between VB3 and W, and VD4 between V_{DD} and V_{SS} .

*3 Flatness of the heat-sink should be lower than 0.15mm.

Electrical Characteristics at $T_c=25^\circ\text{C}$, $V_D=15\text{V}$

Parameter	Symbol	Conditions	min	typ	max	unit
Power output block						
Drain-to-source leak current	I_{DSS}	$V_{DS} = 500\text{V}$			0.1	mA
Boot-strap diode reverse current	I_R (BD)	V_R (BD) = 500V			0.1	mA
Drain-to-source on resistance	R_{DS} (on)	$I_D = 1\text{A}$			5.5	Ω
Diode forward voltage	V_{SD}	$I_D = 1\text{A}$			1.1	V
Boot-strap diode on resistance	RB			200		Ω
Junction-to-substrate thermal resistance	θ_{j-c}				11	$^\circ\text{C}/\text{W}$
Control (Pre-driver) block						
Pre-drive power supply consumption electric current	I_D	VD1, 2, 3 = 15V		0.07	0.4	mA
		VD4 = 15V		1.6	4	
Input ON threshold voltage	V_{inH} (ON)	HIN1, HIN2, HIN3, LIN1, LIN2,	1.5	2.1	2.5	V
Input OFF threshold voltage	V_{inH} (OFF)	LIN3- V_{SS} terminal	0.8	1.3	1.5	V
FAULT/EN clearness delay time	FLTCLR	After each protection operation ending		9		ms
Protection block						
Pre-drive low voltage protection	UVLO		10		12	V
Board Temperature Mounting resistance	R_t	Resistance between the TH and V_{SS} terminals	90	100	110	k Ω
FAULT/EN terminal input electric current	IOSD	During fault operations (low) VFAULT = 0.1V		0.5		mA
ITRIP terminal threshold voltage	VITRIP		0.37	0.46	0.55	V
Switching time	tON	$I_O = 1\text{A}$, Inductive load		0.8		μs
	tOFF			0.9		

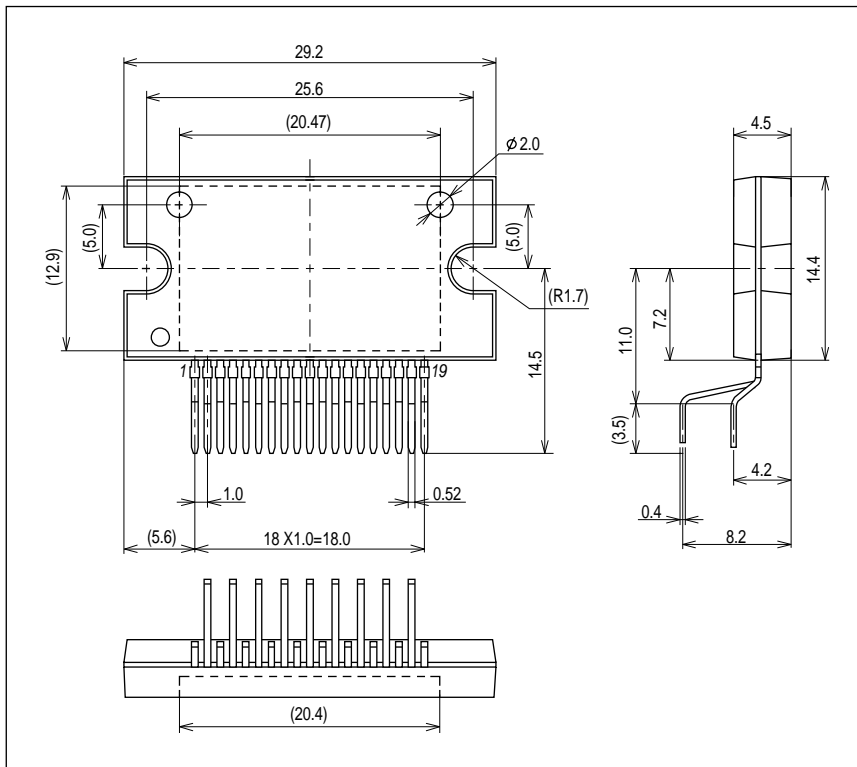
V_{SS} terminal voltage is the reference voltage unless otherwise specified.

Notes

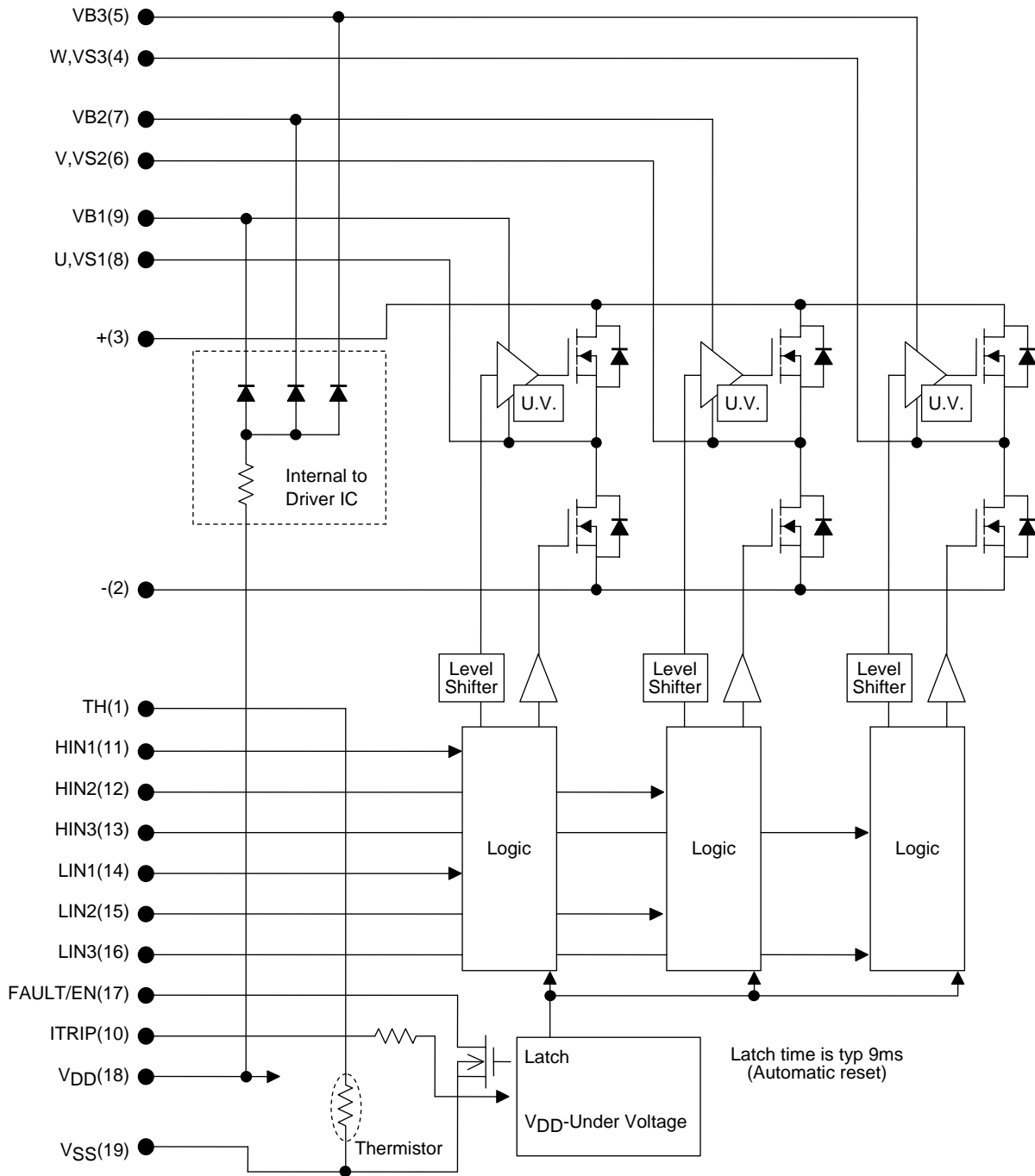
1. Input ON voltage turns on output stage and input OFF voltage turns off output stage.
Apply voltage 3.0V to 5.0V to the V_{IN} (ON) pin to turn output stage on, and apply voltage 0V to 0.3V to the V_{IN} (OFF) pin to turn output stage off.
2. When the internal protection circuit operates, there is a FAULT/EN signal ON (When the FAULT/EN terminal is low level, FAULT/EN signal is ON state: output form is open DRAIN) but the FAULT/EN signal doesn't latch.
After protection operation ends, it returns automatically within about 9ms and resumes operation beginning condition.
So, after FAULT/EN signal detection, set OFF (Low) to all input signals at once.
However, the operation of pre-drive power supply low voltage protection (UVLO: it has a hysteresis about 0.7V) is as follows.
Upper side → There is no FAULT/EN signal output, but it does a corresponding gate signal OFF.
Incidentally, it returns to the regular operation when recovering to the normal voltage, but the latch continues during input signal ON (High).
Lower side → It outputs FAULT/EN signal with gate signal OFF.
However, it is different from the protection operation of upper side, it automatically resets about 9ms later and resumes operation beginning condition when recovering to normal voltage.
(The protection operation doesn't latch by the input signal.)
3. When assembling the hybrid IC on the heat sink, tightening torque range is 0.4N•m to 0.6N•m.
4. The pre-drive low voltage protection is the feature to protect a device when the pre-driver supply voltage declines with the operating malfunction. As for the pre-driver supply voltage decline in case of operation beginning, and so on, we request confirmation in the set.

Package Dimensions

unit:mm (typ)

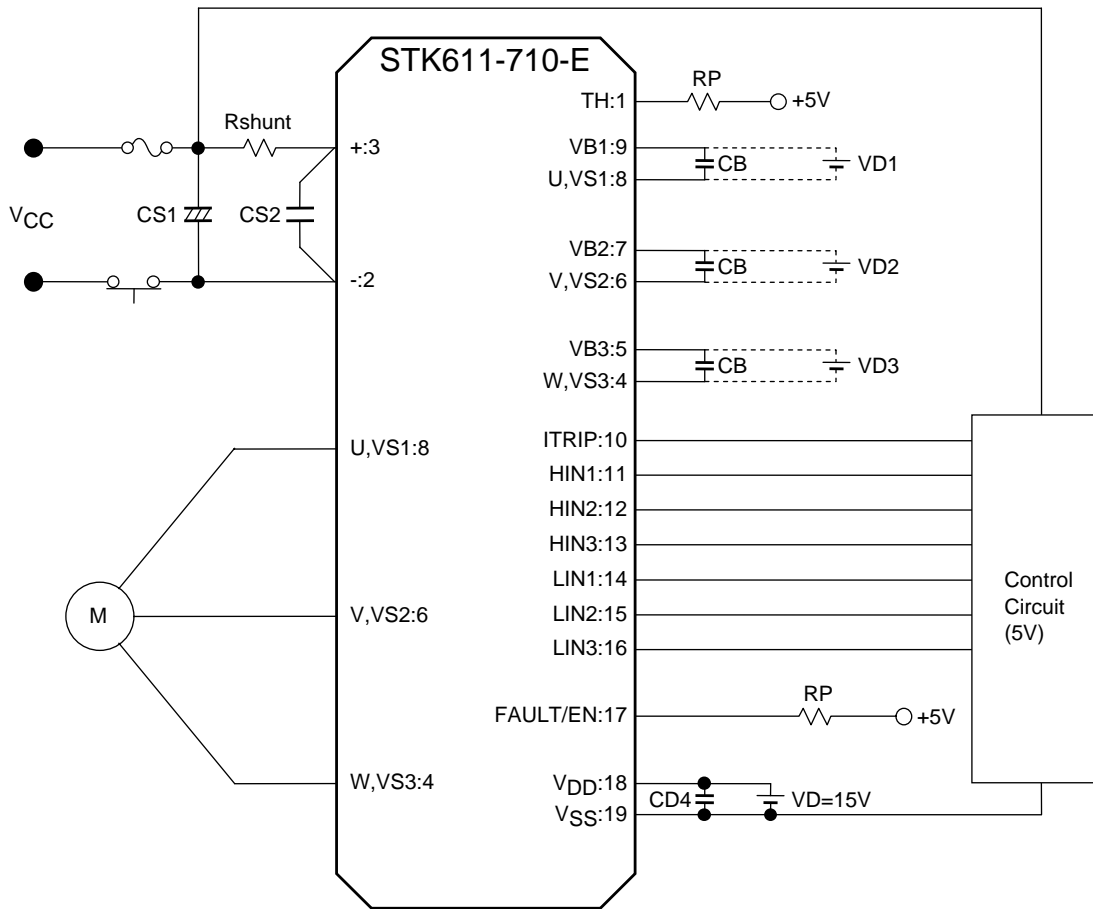


Internal equivalent circuit diagram



STK611-710-E

Example of the application circuit



Recommendation Operating Conditions

Parameter	Symbol	Conditions	min	typ	max	unit
Supply voltage	V_{CC}	+ - - terminal	0		360	V
Pre-driver supply voltage	VD1, 2, 3	VB1 - U, VB2 - V, VB3 - W, terminal	12.5	15	17.5	V
	VD4	$V_{DD} - V_{SS}$ terminal *1	13.5	15	16.5	
ON state input voltage	$V_{IN} (ON)$	HIN1, HIN2, HIN3,	3.0		5.0	V
OFF state input voltage	$V_{IN} (OFF)$	LIN1, LIN2, LIN3 Terminal	0		0.3	
PWM frequency	fPWM		1		20	kHz
Dead-time	DT	Upper/lower input signal downtime	2			μs
Allowable input pulse width	PWIN	ON and OFF	1			μs
Tightening torque	MT	'M3' type screw	0.4		0.6	N•m

*1 Pre-driver power supply (VD4 = $15 \pm 1.5V$) must have the capacity of $I_O = 20mA$ (DC), 0.5A (Peak).

Precautions

1. The STK611-710-E can be driven with a single power supply by placing 1 to 47 μ F bootstrap capacitors (CB) between pins No.4 and No.5, pins No.6 and No.7, and pins No.8 and No.9 for each. In this technique, charge the bootstrap capacitors (CB) by turning the lower side MOSFETs on. (Without this technique, each upper side MOSFET needs external power supply independently.) If more than 47 μ F capacitance is used for this technique, connect a resistor (around 20 Ω) between upper side power supply pin (VB1/2/3) and the capacitor in series for each. Since the capacitance needed depends on the control technique, confirm the adequate capacitance by testing on the actual application.
2. Switching operation can be affected by the floating inductance of the external wiring connected to + and – pins and some voltage spike occurs. To prevent this, shorten the length of wire from CS1 to each pin as much as possible to minimize the wiring inductance. In addition, configure a snubber circuit by connecting a capacitor CS2 of about 10 μ F to suppress surge voltage.
3. The FAULT/EN pin (pin 17) operates when the signal is low (open drain output). This pin is also used to shutdown the internal pre-driver, and when the input voltage is 2.5V or higher the pre-driver operates, when 0.8V or lower the operation is halted. To keep operation on, pull-up resistance is needed externally to have the FAULT/EN pin voltage to be pulled up 2.5V or higher. For the pull-up resistance, connect 6.8k Ω or larger capacitor when VP = 5V, 20k Ω or larger capacitor when VP = 15V.
4. Since the STK611-710-E incorporates a thermistor connected between TH pin (pin 1) and VSS pin (pin 19) the temperature of the substrate can be monitored by connecting a pull-up resistor externally. For the pull-up resistance, connect a 10k Ω or larger resistor when the pull-up voltage (VP) is 5V, 39k Ω or larger when VP is 15V.
5. Though the STK611-710-E incorporates 33k Ω (typ) pull-down resistance connected to signal input pins, to further decrease the influence of wiring noise, connect 2.2k Ω to 3.3k Ω pull-down resistors also externally.
6. The HIC may be destroyed if the motor connecting pin (pins 4, 6, or 8) becomes open when the motor is in rotation. Pay attention to the connecting condition of these pins including soldering condition.
7. ITRIP pin (pin 10) functions as an internal comparator input pin, and apply voltage higher than the Vref voltage (0.44 to 0.55V) to halt the function. (For normal operation, apply voltage up to the Vref level). This pin is to be used to protection functions including overcurrent protection (as a feedback pin from external shunt resistor). Note that since the protection operation is not latched and typically in 2ms after the protection ends the HIC returns to normal operation, set the input signal low (OFF) as soon as the protection operation is detected.
8. When the input signal pulse width is shorter than 1 μ s, there are times the output does not respond to the input signal for neither ON nor OFF operation.

* This sample application circuit does not guarantee the design of mass production.

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