

SPECIFICATION

Product Name **STK5D4-361D-E**

- Case Outline** : DIP(The dual in-line package) of the transfer full mold structure.
- Functions** : This “Inverter Power H-IC” includes the output stage of a 3-phase inverter, pre-drive circuits, a bootstrap circuits , as well as protection circuits in one package.
- Application** : For 3-phase motor drive.
- Features** :
- Protective circuits including pre-drive low voltage protection is built in.
 - Direct input of CMOS level control signals without an insulating circuit is possible.(Active HIGH)
 - A single power supply drive is enabled through the use of bootstrap circuits for upper power supplies. (externally set)
 - 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.)
 - The emitter line of each lower phase transistor is outputting to the external terminal(3 terminals). Therefore, by connecting shunt resistor outside, it is possible to the control which detects 3-phase current.
 - The substrate temperature monitor is enabled through the use of an internal thermistor.

Absolute Maximum Ratings / Tc=25°C

Parameter	Symbol	Remarks	Ratings	Unit
Supply voltage	VCC	+ to U-(V-,W-), surge<500V *1	450	V
Collector-emitter voltage	VCE	+ to U(V,W) or U(V,W) to U-(V-,W-)	600	V
Output current	Io	+,U-,V-,W-,U,V,W terminal current	±10	A
Output peak current 1	Iop	+,U-,V-,W-,U,V,W terminal current P.W=100us	±20	A
Output peak current 2	Iop2	U,V,W terminal current Tc=100°C 0.1Hz Duty 5% Sine wave current (Peak current value)	±18	A
Pre-driver voltage	VD1,2,3,4	VB1 to U, VB2 to V, VB3 to W,VDD to VSS *2	20	V
Input signal voltage	VIN	HIN1, 2, 3, LIN1, 2, 3	0 to 15	V
FLTEN terminal voltage	VFLTEN	FLTEN terminal	20	V
RCIN terminal voltage	VRCIN	RCIN	20	V
ITRIP terminal voltage	VITRIP	ITRIP	5	V
Maximum power dissipation	Pd	IGBT / 1 channel	29.7	W
Junction temperature	Tj	IGBT, FRD	150	°C
Storage temperature	Tstg		-40 to +125	°C
Operating substrate temperature	Tc	H-IC case temperature	-20 to +100	°C
Tightening torque		A screw part *3	1.0	N·m
Withstand voltage	Vis	50Hz sine wave AC 1 minute *4	2000	VRMS

Reference voltage is “Vss” terminal voltage unless otherwise specified.

*1: Surge voltage developed by the switching operation due to the wiring inductance between + and U-(V-, W-) terminal.

*2: VD1=VB1 to U, VD2=VB2 to V, VD3=VB3 to W, VD4=VDD to VSS terminal voltage.

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

*4: Test conditions : AC2500V, 1 second

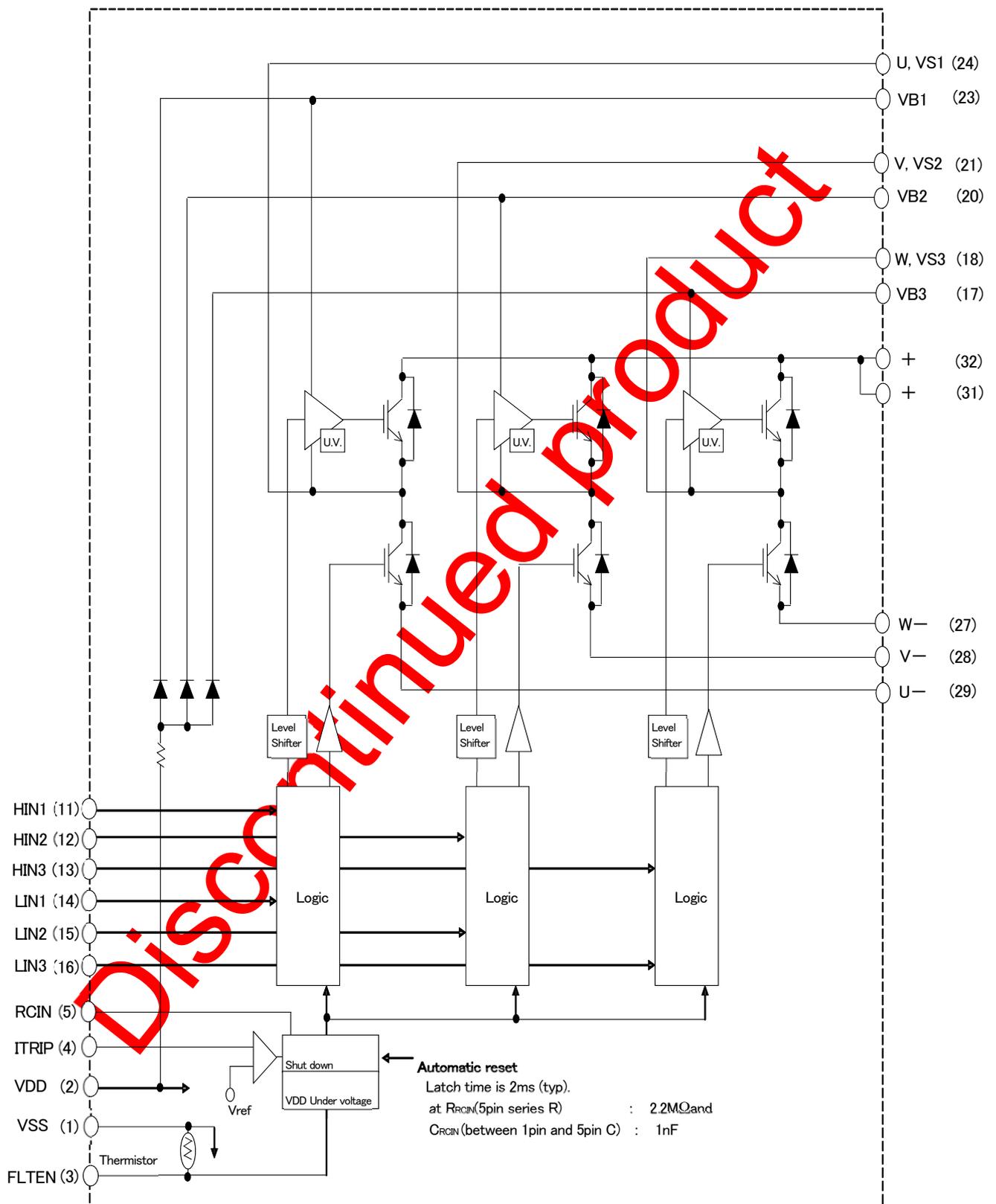
Electrical Characteristics (at Tc=25°C,VD=15V)

Parameter	Symbol	Conditions	Test circuit	MIN	TYP	MAX	Unit
Power output section							
Collector-emitter cut-off current	ICE	VCE = 600V	Fig.1	-	-	0.1	mA
Bootstrap diode reverse current	IR(BD)	VR(BD)		-	-	0.1	mA
Collector-emitter saturation voltage	VCE(SAT)	Io = 10A	Fig.2	-	1.9	2.7	V
Diode forward voltage	VF	Io = -10A	Fig.3	-	1.4	2.1	V
Junction to case thermal resistance	θj-c(T)	IGBT	-	-	-	4.2	°C/W
	θj-c(D)	FWD	-	-	-	8.5	°C/W
Control (Pre-driver) section							
Pre-driver consumption current	ID	VD1,2,3 = 15V	Fig.4	-	0.07	0.4	mA
		VD4 = 15V		-	1.6	4	
Input ON threshold voltage	Vinth(on)	HIN1,HIN2,HIN3, LIN1,LIN2,LIN3 to VSS	-	1.5	2.1	2.5	V
Input OFF threshold voltage	Vinth(off)		-	0.8	1.3	1.5	V
Input threshold voltage hysteresis	Vinth(hvs)		-	(0.5)	(0.8)	-	V
FLTEN terminal input electric current	IoSD	FAULT:ON / VFLTEN=0.1V	-	-	2	-	mA
FLTEN clearness delay time	FLTCLR	After each protection operation ending	-	-	2	-	ms
Pre-drive power supply low voltage protection voltage	UVLO		-	10	-	12	V
ITRIP threshold voltage	VITRIP	ITRIP(4) to VSS(1)	-	0.41	0.465	0.52	V
Resistance for substrate temperature monitors		Resistance between FLTEN(3) and VSS(1)	-	18.5	24.8	30.3	kΩ
Switching time							
Switching time	t ON	Io = 10A	Fig.5	0.3	0.6	1.3	μs
	t OFF	Inductive load		-	0.8	1.5	
Reverse bias safe operating area	RBSOA	Io = 20A , VCE = 450V	-	Full square			-
Short circuit safe operating area	SCSOA	VCE = 200V	-	3	-	-	μs
Allowable offset voltage slew rate	dv/dt	Between U(V,W) to U-(V-,W-)	-	-50	-	50	V/ns

Reference voltage is “Vss” terminal voltage unless otherwise specified.

- 注記**
- 《Input ON threshold voltage》indicates a value to turn on output stage IGBT. 《Input OFF threshold voltage》indicates a value to turn off output stage IGBT. At the time of output ON, set the input signal voltage to Vinth(on)MAX to 15V. At the time of output OFF, set the input signal voltage to 0V to Vinth(off)MIN.
*1: 《Input threshold voltage hysteresis》indicates a reference value based on the design value of built-in pre-driver IC.
 - When the internal protection circuit operates, there is a “FLTEN” signal ON (When the “FLTEN” terminal is low level, “FLTEN” signal is ON state : output form is open DRAIN) but the “FLTEN” signal does not latch. After protection operation ends, it returns automatically within typ 2ms and resumes operation beginning condition. So, after “FLTEN” 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 0.2V) is as follows.
Upper side : There is no “FLTEN” 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 while the input signal is ON (HIGH).
Lower side : It outputs “FLTEN” signal with gate signal OFF. However, it is different from the protection operation of upper side, it is automatically resets and resumes operation beginning condition when recovering to normal voltage. (The protection operation does not latch by the input signal.)
 - When assembling the H-IC on the heat sink, tightening torque range is 0.8N·m to 1.0N·m.
 - The pre-drive low voltage protection is the feature to protect a device when the pre-drive supply voltage declines with an operating malfunction. As for the pre-driver supply voltage decline in case of operation beginning, and so on, we request confirmation in the set.
 - When use the over-current protection with external resistor, please set resistance value so that current protection value becomes equal to or less than the double (2 times) of the rating output electric current (Io).

Equivalent Block Diagram



Test Circuit

(The tested phase : U+ shows the upper side of the U phase and U- shows the lower side of the U phase.)

■ICE / IR(BD)

	U+	V+	W+	U-	V-	W-
M	31,32			24	21	18
N	24	21	18	29	28	27

	U(BD)	V(BD)	W(BD)
M	23	20	17
N	1	1	1

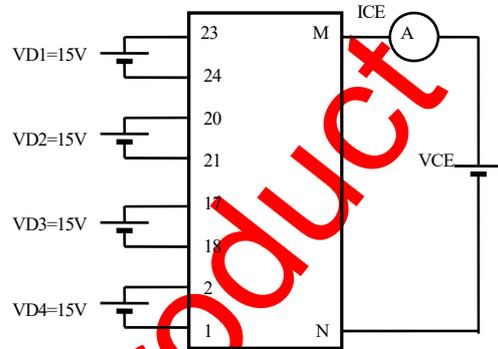


Fig.1

■VCE(SAT) (Test by pulse)

	U+	V+	W+	U-	V-	W-
M	31,32			24	21	18
N	24	21	18	29	28	27
m	11	12	13	14	15	16

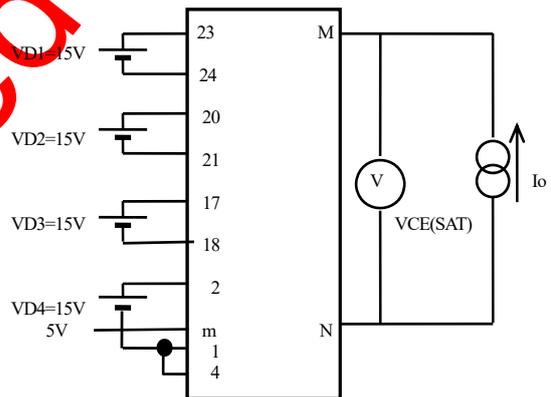


Fig.2

■VF (Test by pulse)

	U+	V+	W+	U-	V-	W-
M	31,32			24	21	18
N	24	21	18	29	28	27

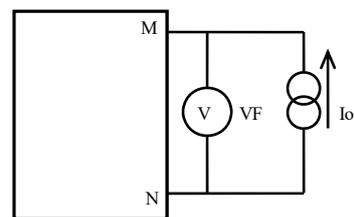


Fig.3

■ID

	VD1	VD2	VD3	VD4
M	23	20	17	2
N	24	21	18	1

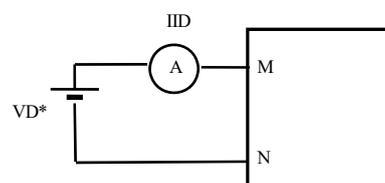


Fig.4

- Switching time (The circuit is a representative example of the lower side U phase.)

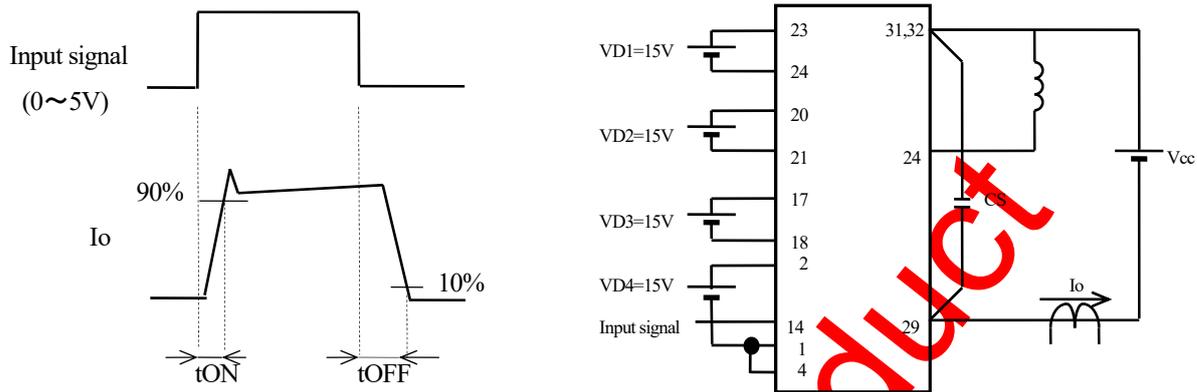
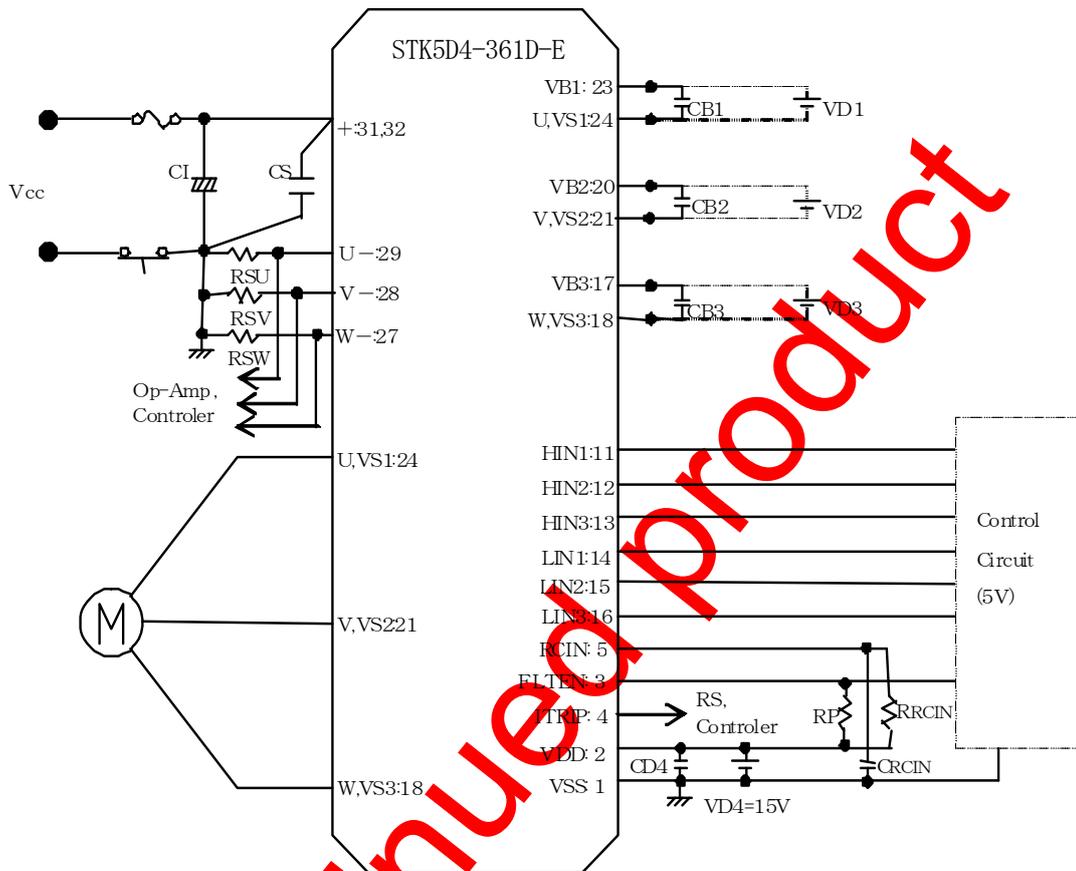


Fig. 5

Discontinued product

Sample Application Circuit



Recommended Operating Condition

Item	Symbol	Conditions	Min.			Typ.
			MIN	TYP	MAX	
Supply voltage	VCC	+ to U-(V-,W-)	0	280	400	V
Pre-driver supply voltage	VD1,2,3	VB1 to U,VB2 to V,VB3 to W	12.5	15	17.5	V
	VD4	VDD to VSS *1	13.5	15	16.5	
ON-state input voltage	VIN(ON)	HIN1,HIN2,HIN3,	3.0	—	5.0	V
OFF-state input voltage	VIN(OFF)	LIN1,LIN2,LIN3	0	—	0.3	
PWM frequency	fPWM		1	—	20	kHz
Dead time	DT	Turn-off to turn-on	1.5	—	—	μs
Allowable input pulse width	PWIN	ON and OFF	1	—	—	μs
Mounting torque		'M3' type screw	0.8	—	1.0	N·m

*1 Pre-drive power supply (VD4=15±1.5V) must be have the capacity of Io=20mA(DC), 0.5A(Peak).

Usage Precaution

1. This H-IC includes bootstrap diode and resistor. Therefore, by adding a capacitor (CB : about 1 to 47μF), a single power supply drive is enabled. In this case, an electric charge is charged to “CB” by making lower side IGBT turn on.
And, please select the capacitance of “CB”(externally set) equal to or less than 47μF(±20%).If selecting the capacitance more than 47μF(±20%), connect a resistor (about 20Ω) in series between each 3-phase upper side power supply terminals(VB1,2,3) and each bootstrap capacitor. Also, the upper side power supply voltage sometimes declines by the way of controlling. Please confirm the voltage with an actual set.(When not using the bootstrap circuit, each upper side pre-drive power supply needs an external independent power supply.)
2. Because the jump voltage which is accompanied by the vibration in case of switching operation occurs by the influence of the floating inductance of the wiring of the outer power supply which is connected with of the “+” terminal and the “U-”(“V-”, “W-”) terminal, restrains and spares surge voltage being as the connection of the snubber circuit (Capacitor / CS /about 0.1uF to 10uF) for the voltage absorption with the neighborhood as possible between the “+” and the point of intersection of the “U-”, “V-” and “W-” terminal, and so on, with making a wiring length (among the terminals each from “CI”)short and making a wiring inductance small.
3. The “FLTEN” terminal (pins 3) is open Drain (It is operating as “FAULT” when becoming Low).This terminal serves as the shut down function of the built-in pre-driver. Please make pulling up outside so that “FLTEN” terminal voltages become more than 3V. (When the terminal voltage is above 3V,normalcy works, and it is shut down when it is equal to or less than 0.8V.) Moreover, thermistor built in between FLTEN(pins 3) and VSS(pins 1), so the substrate temperature can be monitored according to the voltage divided by the themistor and the pull-up resistor.
When the pull up voltage (VP) is at 5V, pull up resistor (RP) connects above 10kΩ, and in case of VP=15V, RP connects above 39kΩ.
The substrate temperature detection by the thermistor is for the substrate temperature monitor in the state of regular operation and not for protection of HIC over-temperature. Moreover, it is not the one to momentary heating-up, and partial heating-up.
4. The pull-down resistor (:33kΩ(typ)) is connected with the inside of the signal input terminal, but please connect the pull-down resistor(about 2.2 to 3.3kΩ) outside to decrease the influence of the noise by wiring etc.
5. It is recommended the installation of the overcurrent protection circuit by the external shunt resistor as HIC protection at an abnormal current of the short-circuit etc. In that case, please select resistance so that the protection current value may become twice or less rated output current (Io).
For safety, recommend installation a fuse, and so on in the “Vcc” line.
6. Please be especially careful of the soldering of the motor connection terminal (pins 18,21 and 24), because the H-IC can be destroyed when this terminal is opened while the motor is running.
7. The “ITRIP” terminal (pins 4) is the input terminal of the built-in comparator. It can stop movement by inputting the voltage more than Vref (0.41V to 0.52V). (At the time of movement, usually give me it for the voltage less than Vref). Please use it as various protections such as the overcurrent protection (feedback from external shunt resistance).
In addition, the protection movement is not done a latch of.
After the protection movement end, I become the movement return state after typ.2ms. Therefore, please do the protection movement detection of all input signals in OFF (LOW) promptly afterward.
8. When input pulse width is less than 1μs, an output may not react to the pulse.(Both ON signal and OFF signal)

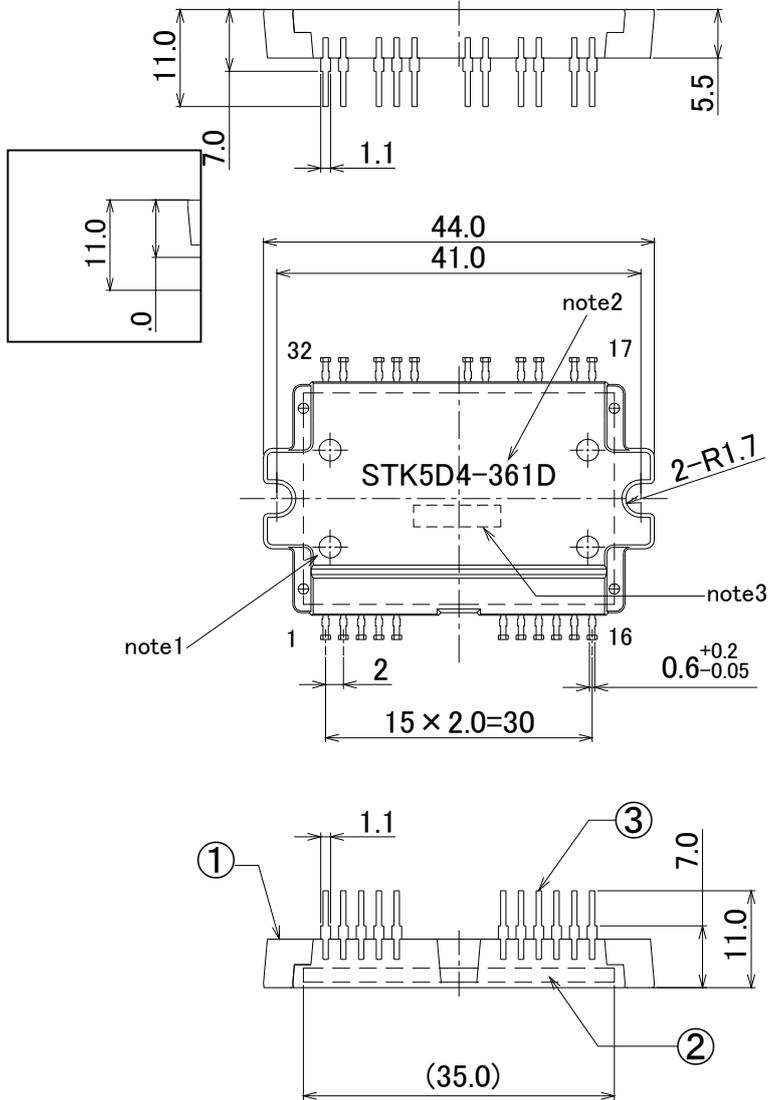
The characteristic of thermistor is as follows.

Parameter	Symbol	Condition	Typ.	Unit
Resistance	R ₂₅	T _c =25°C	100 ± 3%	k Ω
	R ₁₂₅	T _c =125°C	2.52 +11.1%/-9.9%	k Ω
B-Constant(25-50°C)	B		4250 ± 2%	K
Temperature Range			-40 to 125	°C

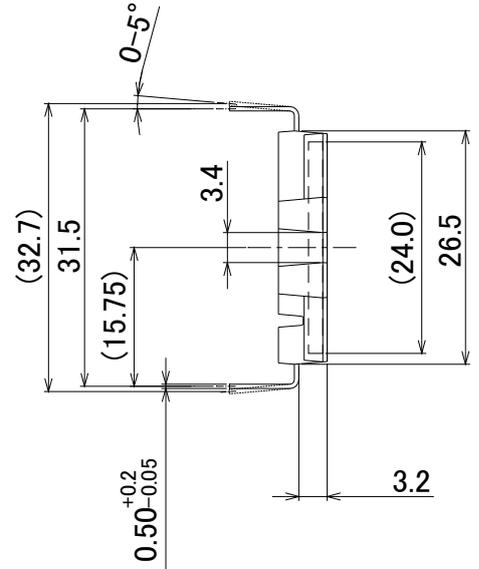
■ This data shows the example of the application circuit, does not guarantee a design as the mass production set.

Package Outline Diagram

Product Name **STK5D4-361D-E**



missing pin : 6,7,8,9,10,19,22,25,26,30



note1: Mark of mirror surface for No.1 pin identification.
 note2: The form of a character in this drawing differs from that of H-IC.
 note3: This indicates the lot code.
 The form of a character in this drawing differs from that of H-IC.

Unit	mm	
Tolerance	±0.5	

Don't scale this drawing.

Control No.	016-11-0030
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No.	Part Name	Material	Treatment
①	Case	EPOXY	
②	Substrate	IMST Substrate	
③	Lead Frame	Cu	Sn

Date	Revision	In charge	Approval