Ordering number : ENA1032A

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Thick-Film Hybrid IC

3-Phase Motor Drive Inverter Hybrid IC

Overview

This IC is a 3-phase inverter power hybrid IC containing power elements (IGBT and FRD), pre-driver, overcurrent and excessive temperature protection circuit.

Application

- 3-phase inverter motor drive

Features

- Integrates power elements (IGBT and FRD), pre-driver, and protective circuit.
- Protective circuits including overcurrent (bus line), excessive temperature and pre-drive low voltage protection are built in.
- Direct input of CMOS level control signals without an insulating circuit (photocoupler, etc) is possible.
- Single power supply drive is possible by using a bootstrap circuit with a built-in IC
- Temperature monitor is possible by the thermistor inside the IC
- 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.)
- SIP (The single in-line package) of the transfer full mold structure.

Specifications

Absolute Maximum Ratings at Tc = 25°C

Parameter	Symbol	Conditions		Ratings	unit
Supply voltage	V_{CC}	+ - –, surge < 500V	*1	450	V
Collector-emitter voltage	V_{CE}	+ - U (V, W) or U (V, W) - –		600	V
Output current	I_O	+, –, U, V, W terminal current		±30	A
Output peak current	Iop	+, –, U, V, W terminal current PW = 100µs		±45	A
Pre-driver supply voltage	VD1, 2, 3, 4	VB1 - U, VB2 - V, VB3 - W, V_{DD} - V_{SS}	*2	20	V
Input signal voltage	V_{IN}	HIN1, 2, 3, LIN1, 2, 3 terminal		0 to 7	V
FAULT terminal voltage	VFAULT	FAULT terminal		20	V
Maximum loss	Pd	Per 1 channel		49	W
Junction temperature	Tj	IGBT, FRD junction temperature		150	°C
Storage temperature	Tstg			-40 to +125	°C
Operating temperature	TC	H-IC case temperature		-20 to +100	°C
Tightening torque		A screw part at use M4 type screw	*3	1.17	N•m
Withstand voltage	Vis	50Hz sine wave AC 1 minute	*4	2000	VRMS

In the case without the instruction, the voltage standard is - terminal = V_{SS} terminal voltage.

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

*2 VD1 = between VB1-U, VD2 = VB2-V, VD3 = VB3-W, VB4 = V_{DD}-V_{SS}, terminal voltage.

*3 Flatness of the heat-sink should be lower than 0.25mm.

*4 The test condition is AC 2500V, 1 second.

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.

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

Parameter	Symbol	Conditions		Test Circuit	Ratings			unit
					min	typ	max	
Power output part								
Collector-to-emitter cut-off current	I_{CE}	V_{CE} = 600V		Fig.1			0.5	mA
Boot-strap diode reverse current	IR (BD)	VR (BD) = 600V		Fig.1			0.5	mA
Collector-to-emitter saturation voltage	V_{CE} (SAT)	I_O = 15A	Upper side	Fig.2		1.8		V
			Lower side			2.0		V
Diode forward voltage	V_F	I_O = -15A	Upper side	Fig.3		1.7		V
			Lower side			1.9		V
Junction-to-substrate thermal resistance	θj-c (T)	IGBT				2.1		°C/W
	θj-c (D)	FWD				2.5		°C/W
Control (Pre-driver) part								
Pre-drive power supply consumption electric current	I_D	VD1, 2, 3 = 15V		Fig.4		0.07	0.4	mA
		VD4 = 15V				2	5	
Input ON voltage	V_{IH}	Output ON					0.8	V
Input OFF voltage	V_{IL}	Output OFF			3.0			V
Protection part								
Excessive temperature	TSD	The substrate surface			100		120	°C
Overcurrent protection electric current	ISD	PW = 100µs		Fig.5	46		58	A
Pre-drive low voltage protection	UVLO				10		12	V
Fault terminal input electric current	IOSD	VFault = 0.1V				0.5		mA
Fault clearness delay time	FLTCLR	After each protection operation ending			18		80	ms
Board Temperature Mounting resistance	Rt	Resistance between the Fault and V_{SS} terminals			90		110	kΩ
Switching time	tON	I_O = 15A, Inductive load		Fig.6		0.8		µs
	tOFF					1.0		µs
Electric current output signal level	ISO	I_O = 15A				0.141		V

In the case without the instruction, the voltage standard is - terminal = V_{SS} terminal voltage.

Notes

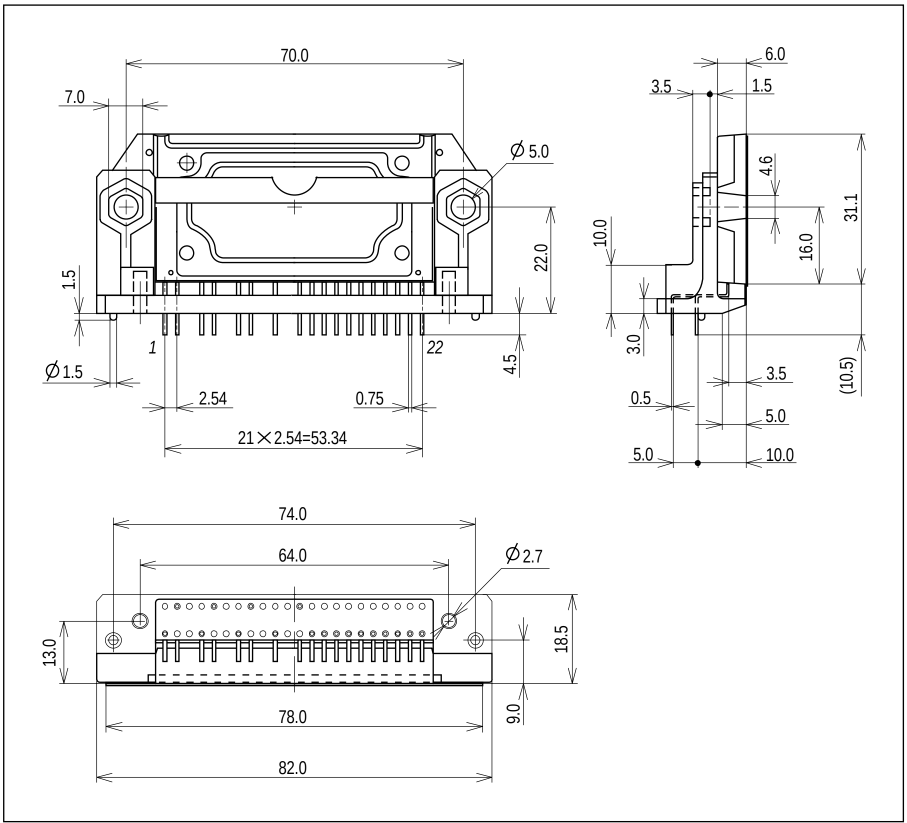
1. Input ON voltage indicates a value to turn on output stage IGBT.
   Input OFF voltage indicates a value to turn off output stage IGBT.
   At the time of output ON, set the input signal voltage 0V to V_{IH} (MAX).
   At the time of output OFF, set the input signal voltage V_{IL} (MIN) to 5V.

2. When the internal protection circuit operates, there is a Fault signal ON (When the Fault terminal is low level, Fault signal is ON state : output form is open DRAIN) but the Fault signal doesn't latch.
   After protection operation ends, it returns automatically within about 18ms to 80ms and resumes operation beginning condition. So, after Fault signal detection, set OFF (HIGH) to all input signals at once.
   However, the operation of pre-drive power supply low voltage protection (UVLO: it has a hysteresis about 0.3V) is as follows.
   Upper side → There is no Fault 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 among input signal ON (LOW).
   Lower side → It outputs Fault signal with gate signal OFF.
   However, it is different from the protection operation of upper side, it is automatically resets about 18ms to 80ms 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 with M4 type screw, tightening torque range is 0.79N•m to 1.17N•m.
   Flatness of the heat-sink should be lower than 0.25mm.

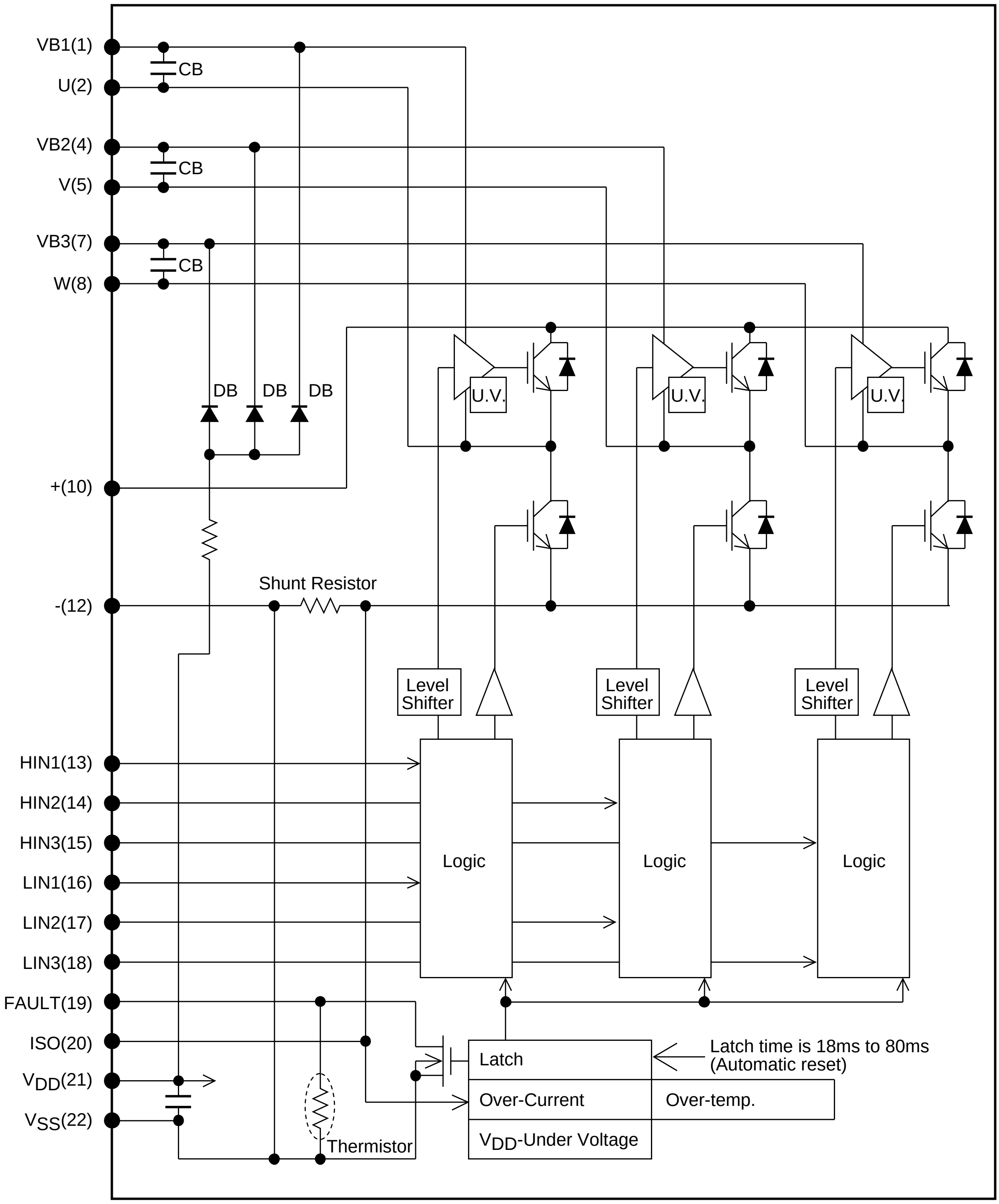
4. The pre-drive low voltage protection is the feature to protect a device when the pre-driver supply voltage declines with the operating malfunction. As for the pre-driver supply voltage decline in case of operation beginning, and so on, we request confirmation in the set.

Package Dimensions

unit:mm (typ)



Internal Equivalent Circuit Diagram



Test Circuit

Fig 1: I_{CE}

	U+	V+	W+	U-	V-	W-
M	10	10	10	2	5	8
N	2	5	8	12	12	12

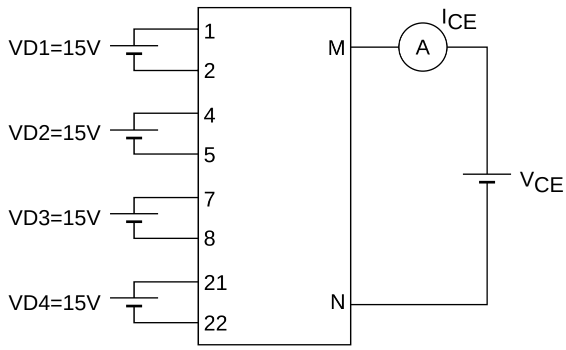


Fig 2: V_{CE}(SAT)

	U+	V+	W+	U-	V-	W-
M	10	10	10	2	5	8
N	2	5	8	12	12	12
m	13	14	15	16	17	18

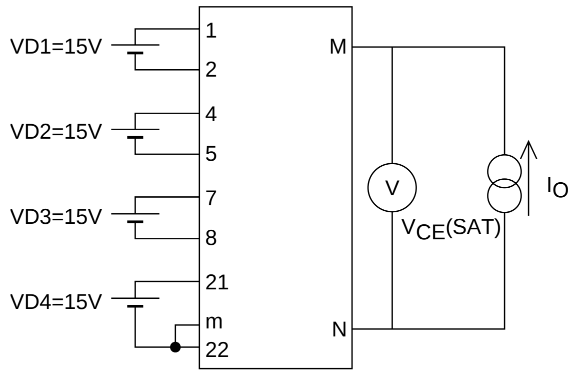


Fig 3: V_F

	U+	V+	W+	U-	V-	W-
M	10	10	10	2	5	8
N	2	5	8	12	12	12

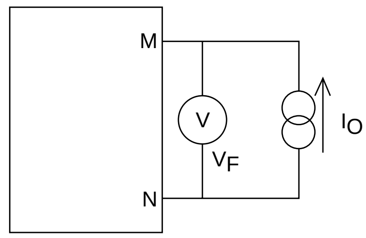


Fig 4: I_D

	VD1	VD2	VD3	VD4
m	1	4	7	21
n	2	5	8	22

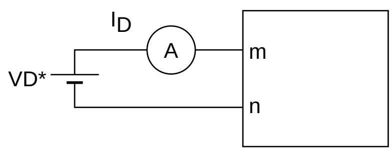


Fig 5: ISD

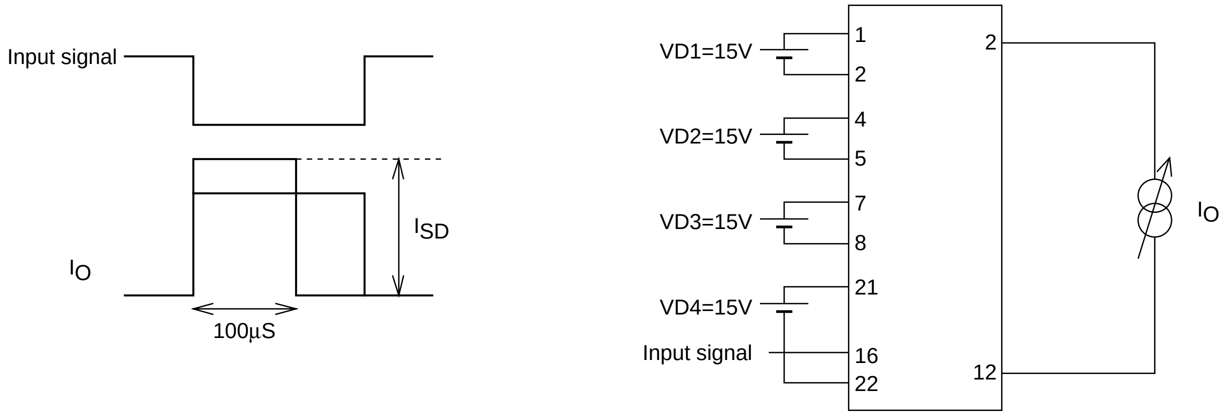
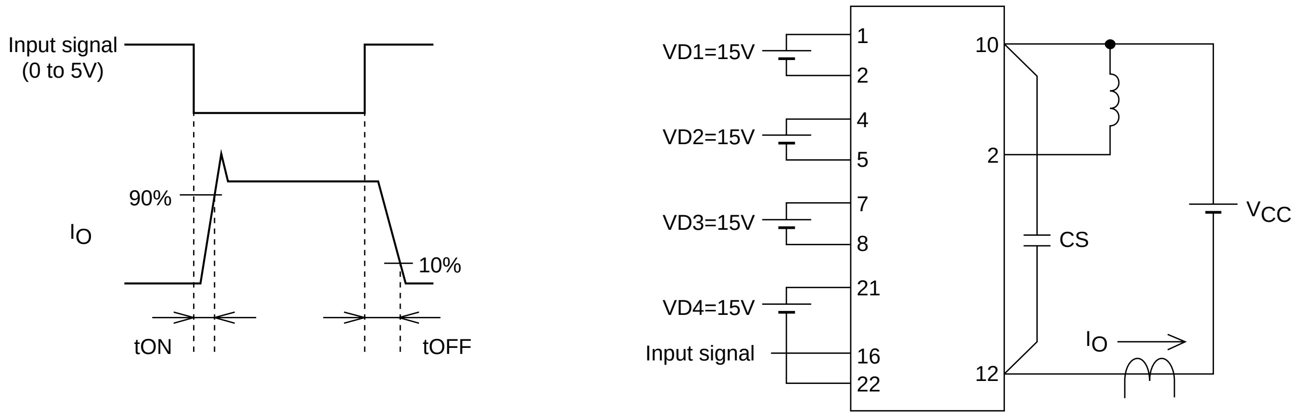
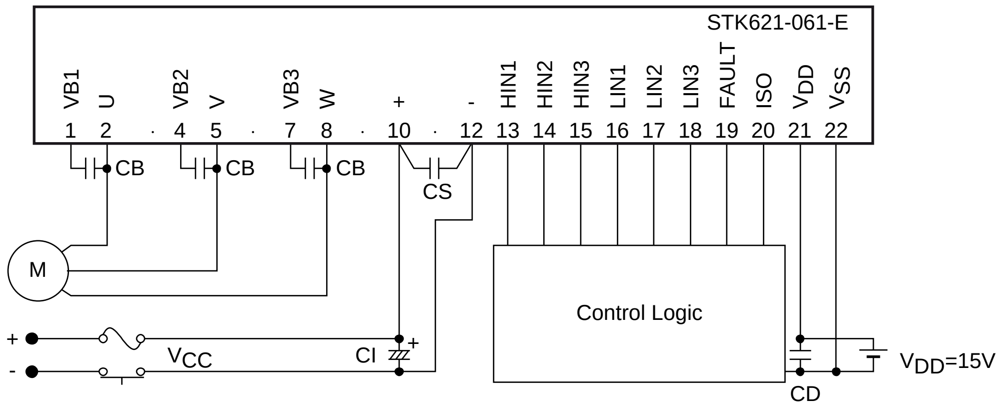


Fig 6: Switching Time



Example of the application circuit



Recommendation Operating Conditions

Parameter	Symbol	Conditions	min	typ	max	unit
Supply voltage	V_{CC}	+ - –	0	280	400	V
Pre-driver supply voltage	VD1, 2, 3	VB1 - U, VB2 - V, VB3 - W	12.5	15	17.5	V
	VD4	V_{DD} - V_{SS} *1	13.5	15	16.5	
Input ON voltage	V_{IN}(ON)	HIN1, HIN2, HIN3, LIN1, LIN2, LIN3 Terminal	0		0.3	V
Input OFF voltage	V_{IN}(OFF)		3.5		5	
PWM frequency	fPWM		1		20	kHz
Dead time	DT	Upper/lower input signal downtime	2			µs
Tightening torque	MT	‘M4’ Type Screw	0.79		1.17	N•m

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

Usage Precaution

1. Single power supply drive is possible by using a bootstrap circuit with a built-in IC.
   (When not using bootstrap circuit, each upper side pre-drive power supply needs an independent power supply. Externally set.)
   Also, the upper side power supply voltage sometimes declines by the way of controlling. Confirm it.

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 –terminal, restrains and spares serge voltage being as the connection of the snubber circuit (Capacitor/CS/about 0.1 - 10µF) for the voltage absorption with the neighborhood as possible between + and the -terminal, and so on, with making a wiring length (among the terminals each from CI) short and making a wiring inductance small.

3. ISO terminal (20pin) is for the electric current monitor. Be careful, because the overcurrent protection does not operate when short-circuiting in the ISO terminal and the V_{SS} terminal.

4. Output form of the FAULT terminal is open DRAIN (it is operating as FAULT when becoming LOW).
   When the pull up with the resistance, use above 5.6kΩ.

5. Zener diode with 5V (5.0 - 5.4V) is connected with the inside of the signal input terminal.When inputting the voltage which exceeds 5V,connect resistor to between the side of the power and the signal input terminal,for the input current of the signal input terminal become equal to or less than 0.5mA.
   This resistor is effective with the noise absorption of the signal terminal,too.

6. The overcurrent protection feature operates only when it is possible to do a circuit control normally. For the safety, put a fuse, and so on in the V_{CC} line.

7. Because the IC sometimes destroys and bursts when motor connection terminal (2pin, 5pin, 8pin) becomes open while the motor turns, especially, be careful of the connection (the soldering condition) of this terminal.

8. If - terminal and V_{SS} terminal are short-circuited, since an over-current protection (ISD) value will become lower than the inside setting value of HIC, please do not connect externally.
   (–terminal and V_{SS} terminal are connected inside HIC)

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