

Hybrid integrated IGBT driver



Patent protection RoHS

## Recommended modules

- 600V series IGBT (current  $\leq 600A$ )
- 1,200V series IGBT (current  $\leq 400A$ )
- 1,700V series IGBT (current  $\leq 200A$ )

## Applications

- General inverter
- AC servo drive system
- Uninterruptible power supply (UPS)
- Electric welding machine

QC962-8A is an integrated hybrid IGBT driver. Its main function is to receive the square wave signal from the controller, and convert it into an isolated, amplified gate signal which controls the IGBT's turn-on and turn off cycle. It is a square wave signal through the optocoupler that provides reliable electrical isolation, therefore the control system cannot be affected by the common mode interference caused by IGBT. In addition, the QC962-8A driver can also be used to detect the undersaturated voltage drop of the IGBT collector to quickly identify the IGBT's overcurrent or short circuit state and trigger the protection function, so as to avoid IGBT being burned in the fault conditions, afterwards the controller will issue a warning signal.

## FEATURES

- Built-in high CMRR opto-coupler (CMR: 30kV/ $\mu s$  typ., 15kV/ $\mu s$  min.)
- Built in bi-polar power supply
- Input signal compatible with CMOS & TTL level
- High-isolation voltage opto-coupler (3750Vrms/min)
- Short-circuit protection and output fault function
- Soft shut-down and reset timer can be used during over-current fault
- Adjustable controlled time for detecting short circuit
- Switching frequency up to 40kHz
- Drop-in replacement to M57962AL (See compatibility notes)

## Maximum ratings

Item	Symbol	Test Conditions	Value	Unit
Power Supply Input Voltage	$V_{CC}$	DC	18	V
	$V_{EE}$		-15	
Current Input During High Level Signal Status	$I_{IH}$	Between Terminal 13 and 14	25	mA
Voltage Input During High Level Signal Status	$V_{IH}$	No Limiting Current Resistance	5.25	V
Drive Output Voltage	$V_o +$	Input Signal Is High	$V_{CC}$	V
	$V_o -$	Input Signal Is Low	$V_{EE}$	
Output Current	$I_{gon}$	Pulse Width : 2 $\mu s$ Frequency f = 20kHz	+8	A
	$I_{goff}$		-8	
Input & Output Isolation Test	$V_{ISO}$	Sine Wave 50Hz / 60Hz, 1min., Leakage Current <1mA	3750	VAC
Fault Output Current	$I_{FO}$	Pin8 Input Current	20	mA
Max. Input Voltage to Fault Detect Pin	$V_{R1}$	Pin1 Input Voltage	50	V
Operating Temperature	$T_{OP}$		- 40°C to + 70°C	--
Storage Temperature	$T_{ST}$		- 50 °C to + 125°C	
Note: 1. Ambient temperature is Ta=25°C, unless otherwise specified; 2. 20V < V <sub>CC</sub> -V <sub>EE</sub> < 28V.				

### Input Specifications

Item	Symbol	Testing Conditions	Min.	Typ.	Max.	Unit
Power Supply Input Voltage	$V_{CC}$	DC input	14	15	--	V
	$V_{EE}$	DC input	-7	-10	--	
Current Input During High Level Signal Status	$I_{IH}$	Between Terminal 13 and Terminal 14	10	16	20	mA

### Output Specifications

Item	Symbol	Testing Conditions	Min.	Typ.	Max.	Unit
Voltage Output During High Level Signal Status	$V_{OH}$	f=20kHz	13	14	--	V
Voltage Output During Low Level Signal Status	$V_{OL}$		-6	-9	--	

### General Specifications

Item	Symbol	Testing Conditions	Min.	Typ.	Max.	Unit
Switching Frequency	$f$	$R_g = 5\ \Omega$	0	20	40	kHz
Gate Resistance	$R_g$		2	--	--	$\Omega$
Turn-on Delay Time	$T_{PLH}$	$I_{IH} = 16\text{mA}$ $V_{CC} = 15\text{V}$ $V_{EE} = -10\text{V}$ $R_g = 2\ \Omega$ $f = 20\text{kHz}$	--	0.4	1	$\mu\text{s}$
Turn-on Rise Time	$T_R$		--	0.6	0.8	
Turn-off Delay Time	$T_{PHL}$		--	0.6	1.3	
Turn-off Fall Time	$T_F$		--	0.4	0.8	
Threshold Voltage Protection	$V_{OCP}$	$V_{CC} = 15\text{V}; V_{EE} = -10\text{V}$	--	9.2	--	V
Protective Reset Time	$T_{timer}$	Duration From Start to End of Protective Signal	1	1.3	2	ms
Fault Output Current	$I_{FO}$	Pin8 Input Current, $R = 4.7\text{k}\ \Omega$	--	5	--	mA
Short Circuit Detecting Time (Blind Zone Time)	$T_{trip}$	During the protection operation, the voltage at Pin1: $\geq 15\text{V}$ , Pin2: Open	--	2.6	--	$\mu\text{s}$
Protective Soft Turn-off Time	$T_{CF}$	During the protection operation, the voltage at Pin1: $\geq 15\text{V}$	--	5	--	
Output of Quantity of Electric Charge	$Q_g$	$R_g = 2\ \Omega$ , $C_g = 160\text{nF}$ , $V_{CC} = 15\text{V}$ , $V_{EE} = -10\text{V}$	--	3.4	4.0	$\mu\text{C}$
Rated Power of The Module	$P_{in}$	$R_g = 2\ \Omega$ , $C_g = 160\text{nF}$ , $V_{CC} = 15\text{V}$ , $V_{EE} = -10\text{V}$ , $f = 20\text{kHz}$	--	3.4	--	W
Weight	$W$		--	5.1	--	g

Note: Unless otherwise specified,  $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 15\text{V}$ ,  $V_{EE} = -10\text{V}$ .

## Design Reference

## 1. Typical application circuit

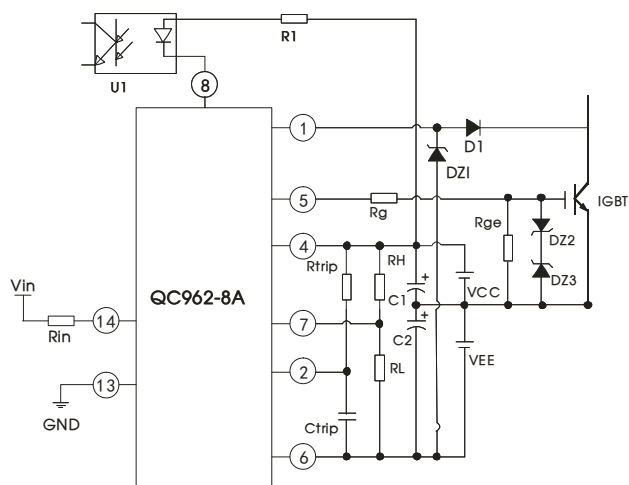


Fig.1 Circuit diagram

TTL & CMOS compatible

 $f = 20\text{kHz}$ 

$V_{in} = 3.3 \text{ to } 5V$

 $V_{CC} = 15V$ 
$$V_{EE} = -10V$$
$$R_g = 2 \Omega$$

D<sub>1</sub>: fast recovery diode ( $t_{rr} \leq 0.2 \mu s$ )

DZ1: 30V TVS

DZ2, DZ3: 18V

$$R1 = 4.7k\Omega$$
$$R_{ge} = 10k\Omega$$

C1, C2: 100μF (low ESR)

RH, RL, Rtrip and Ctrip do not need to be added, and external connection is required.

Note: 1. For further ripple & noise reduction, connect an additional capacitor each with a value between 1 $\mu$ F and 10 $\mu$ F in parallel with capacitors C1 and C2

2. D1 should be selected according to the voltage of the bus. Generally,  $U_{D1}$  should be greater than or equal to twice the voltage of the bus. In practice,  $U_{D1}$  should be based on the customer's application environment.

## 2. Description of Characteristic

### 1) Short circuit protection

QC962-8A driver's detecting of a short circuit condition can be divided into the three following scenarios:

A. Short circuit protection signal time is less than short circuit protection suppression time:

The driver is a normal state that the fault output is forbidden;

B. Short circuit protection signal time is longer than suppression time:

The short circuit signal disappears at the course of the drive control signal falls, the driver triggers the short circuit protection and resume normal work after short circuit signal expires.

C. Short circuit signal time is longer than self-recovery time:

Driver triggers short circuit protection and restores periodic detection signal issued from the circuit to resume normal operation after short signal expires.

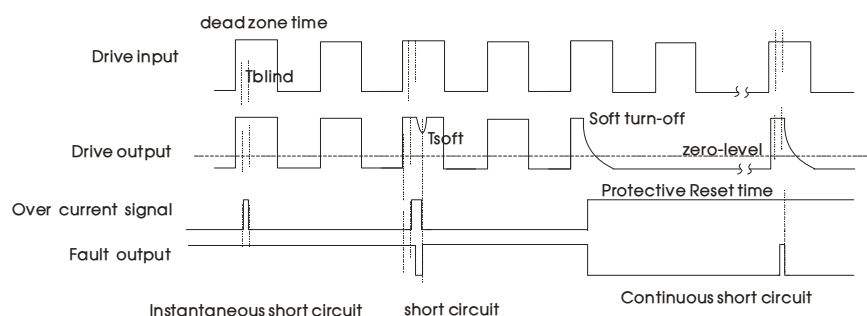


Fig.2: Protection sequence diagram

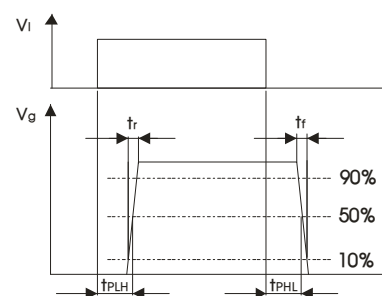


Fig.3: Signal delay of Overcurrent/Short-circuit

2) Input and Output delay time, rise time and fall time characteristics are defined in Fig.3.

3) Product operating temperature and operating frequency derate

It is suggested that the IGBT driver ambient temperature is decided for environment temperature and signal frequency.

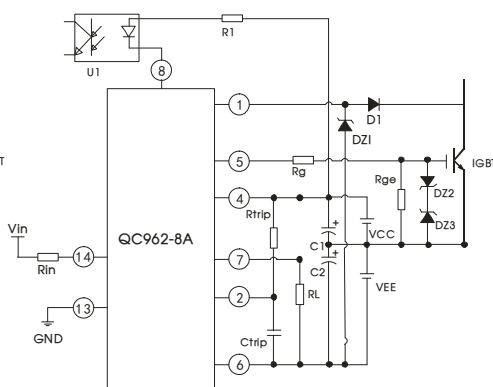
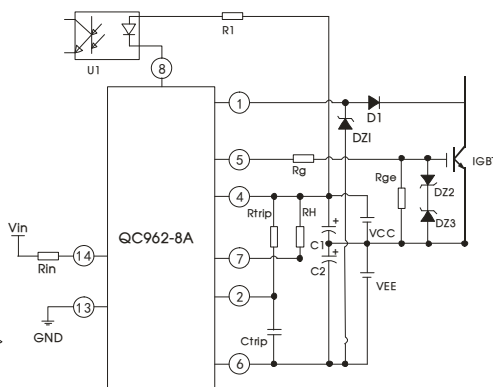
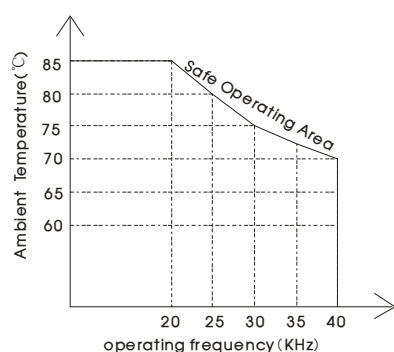


Fig.4: QC962-8A driver safe operating area Fig.5: Protection of threshold voltage Reduction Fig.6: Protection of threshold voltage Increase

### 3. Parameter adjustment

#### 1) Over current protection threshold voltage regulation characteristics:

Over current protection threshold voltage (threshold level where protection starts) is the point where the IGBT drive is detecting an IGBT over current. The QC962-8A product has a function of regulating protection threshold voltage, that is user adjustable by means of external resistors RH and RL which regulate the over current protection threshold voltage value. The proposed adjusted voltage value Vocp cannot be lower than 8V and should not be higher than 10V as shown in the specific adjustment table below. Note that the values in this table are for reference only and must be verified to suite the actual application

RH(k $\Omega$ )	RL(k $\Omega$ )	Vocp(V)	Ttrip(us)	Note
12	—	10.5	2.52	Test conditions Vcc=15V VEE=-10V f=25kHz
24	—	10.0	2.42	
—	—	9.4	2.32	
—	150	8.8	2.22	
—	100	8.5	2.18	
—	51	8.0	1.90	

Over current protection threshold voltage is affected by the power supply voltage; the higher Vcc, the higher the over-current protection threshold voltage and the lower Vee, the higher the over-current protection threshold voltage and vice versa. At the same time the over-current protection threshold voltage level also affects the short circuit protection suppression time length. threshold voltage the higher the inhibition time shorter, short circuit protection, Please refer to short circuit protection inhibition time regulation characteristics for adjusting the short circuit protection time to obtain a reasonable short circuit protection and inhibition time.

#### 2) Adjusting the short-circuit detection time delay

The short-circuit detection time delay is defined between the time in which a desaturation is detected and the time in which the gate voltage drops to 90% of extent. This driver has a minimum short-circuit detection time delay. This short-circuit detection time delay can be adjust by connecting the Ctrip capacitor between pin 2 and 6, however the short-circuit detection time delay must be set to less than 3.5  $\mu$ s. Please also refer to table 2 below (values for reference only).

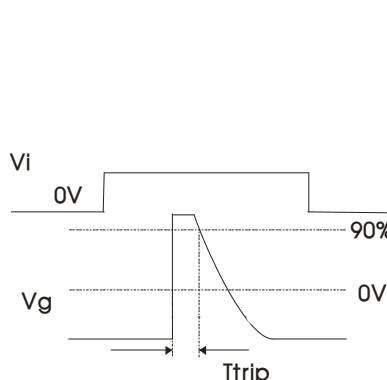


Fig.7: Protective inhibition test

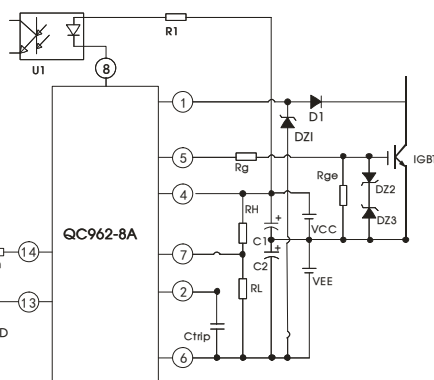


Fig.8: Increase protective inhibition time

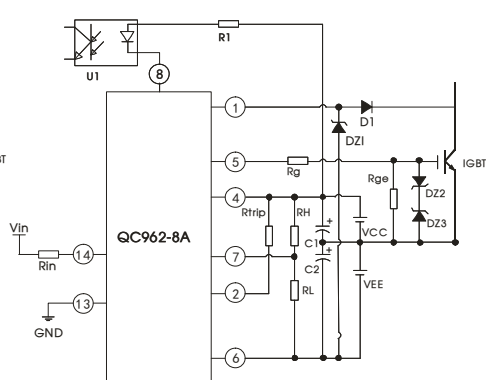


Fig.9: Reduce protective inhibition time

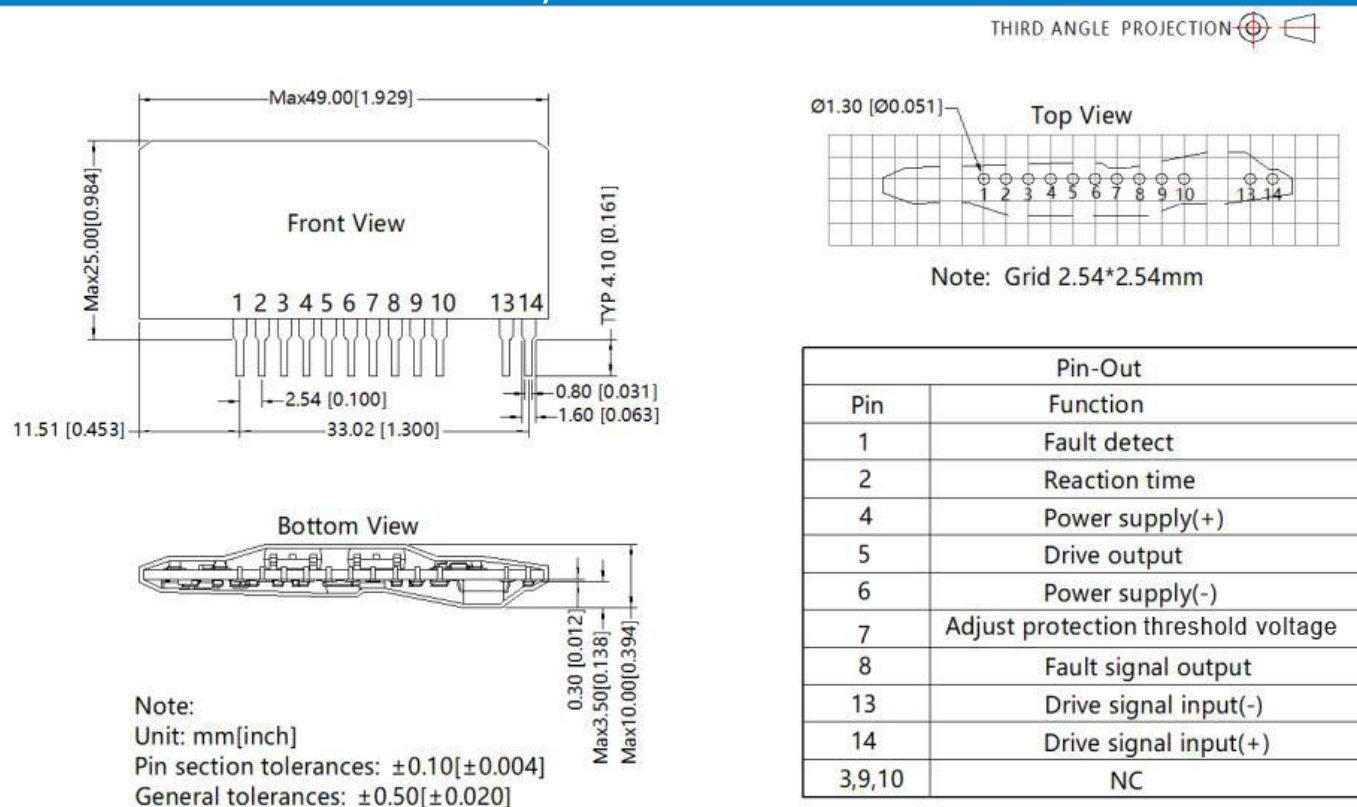
Ctrip (nF)	Rtrip (k $\Omega$ )	Ttrip (us)	Note
—	—	2.34	Test conditions $V_{CC} = 15V$ $V_{EE} = -10V$ $f = 25kHz$ $R_g = 2\Omega$
—	51	2.06	
—	20	1.80	
4.7	—	3.16	
4.7	51	2.74	
4.7	20	2.34	
10	—	4.30	
10	51	3.70	
10	20	3.14	

#### 4. Compatibility feature

This product's basic parameter and function of pin are compatible with M57962AL series, so it can be directly replaced if without special requirements, and alternative use should pay attention to the following points:

- 1) Relative to the M57962AL product our QC962-8A driver has the added threshold protection regulation function at pin 7. To properly use this function please refer to the over current threshold adjustment characteristics and procedure. Leave pin without electrical connection if the adjustment function is not being used.
- 2) Relative to the M57962AL product our QC962-8A driver has the added short-circuit protection inhibition time adjusting function at pin 2. To properly use this function please refer to the short circuit protection inhibition time adjustment characteristics. Leave pin without electrical connection if the adjustment function is not being used.
- 3) Pin 3, 9 and 10 are left floating in the application (used in production testing process only);
- 4) Highest peak output current is with 8A higher than the relative peak output current of M57962AL product. This can be user adjusted according to the actual need by selecting the appropriate gate limit circuit resistance  $R_g$ .
- 5) For additional information please refer to application notes on [www.mornsun-power.com](http://www.mornsun-power.com)

#### Dimensions and Recommended Layout



Note:

1. For additional information on Product Packaging please refer to [www.mornsun-power.com](http://www.mornsun-power.com). The Packaging bag number:58230001;
2. The driver must be wired as short as possible to the IGBT module's gate and emitter terminals (1m max.);
3. Twisted pair is recommended for the connection of the driver to the gate and emitter of the IGBT;
4. In order to reduce the high peak voltage generated at the collector of the IGBT turn-off, it is recommended to increase the gate resistance appropriately;
5. Pin 3, 9 and 10 are used for the test circuit only and must NOT be connected;
6. The external blocking capacitors must be connected as close as possible to the pins of the driver;
7. Select diode D1 with a peak reverse voltage that is higher than the peak value of the IGBT collector voltage;
8. The distance between capacitor Ctrip and pin 2-6 should be as short as possible, but no longer than 5cm max.;
9. The 30V Zener diode DZ1 is connected between pin 1 and pin 6, protecting the driver from the reverse recovery characteristic of the diode D1 which could generate an excessive voltage on pin 1;
10. Higher input signal voltage results in higher input signal current and therefore higher dissipation. The input port's circuit is composed of a high-speed optocoupler series with a 150ohm resistor. Practically, a current limiting resistor is inserted and its value can be obtained from the following equation: 
$$R_{in} = \frac{V_{in} - 1.7V}{16mA} - 150\Omega$$
11. Unless otherwise specified, parameters in this datasheet were measured under the conditions of Ta=25℃, humidity<75%RH with nominal input voltage and rated output load;
12. All index testing methods in this datasheet are based on company corporate standards;
13. The above are the performance indicators of the product models listed in this datasheet. Some indicators of non-standard models will exceed the above requirements. For details, please contact our technical staff;
14. We can provide product customization service, please contact our technicians directly for specific information ;
15. Products are related to laws and regulations: see "Features" ;
16. Our products shall be classified according to ISO14001 and related environmental laws and regulations, and shall be handled by qualified units.

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