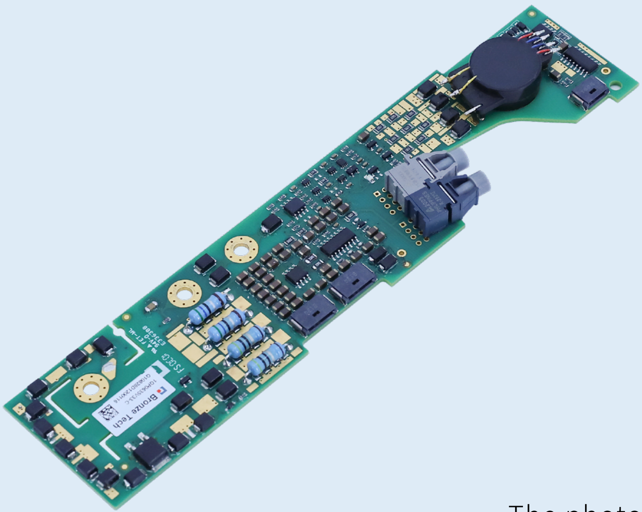
1QP0635Vxx

Description & Application Manual

RoHS
COMPLIANT



The photo is for reference only.

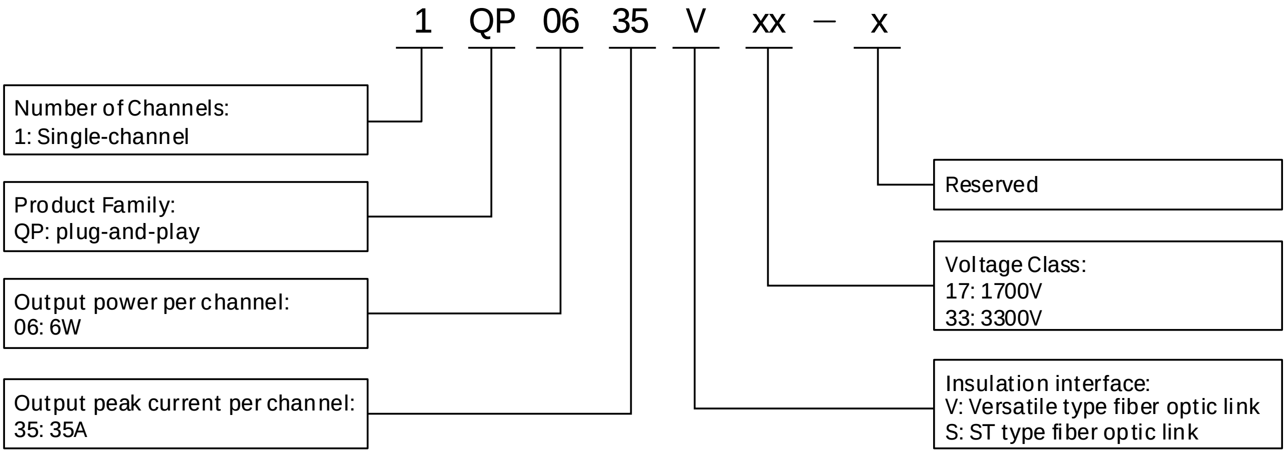
Description

1QP0635Vxx is a single-channel, high-power, high-reliability and highly integrated IGBT driver designed for single-channel, high-voltage (≤ 3300V) applications based on the ASIC chipset developed in-house by Bronze Technologies. Multi-parallel (up to 4) connection is possible.

1QP0635Vxx is suitable for IGBT modules in IHM or similar packages. The plug-and-play function allows the driver be directly mounted on the IGBT module with screws, without any adapters.

Contents

Nomenclature



Block Diagram Of Driver Board

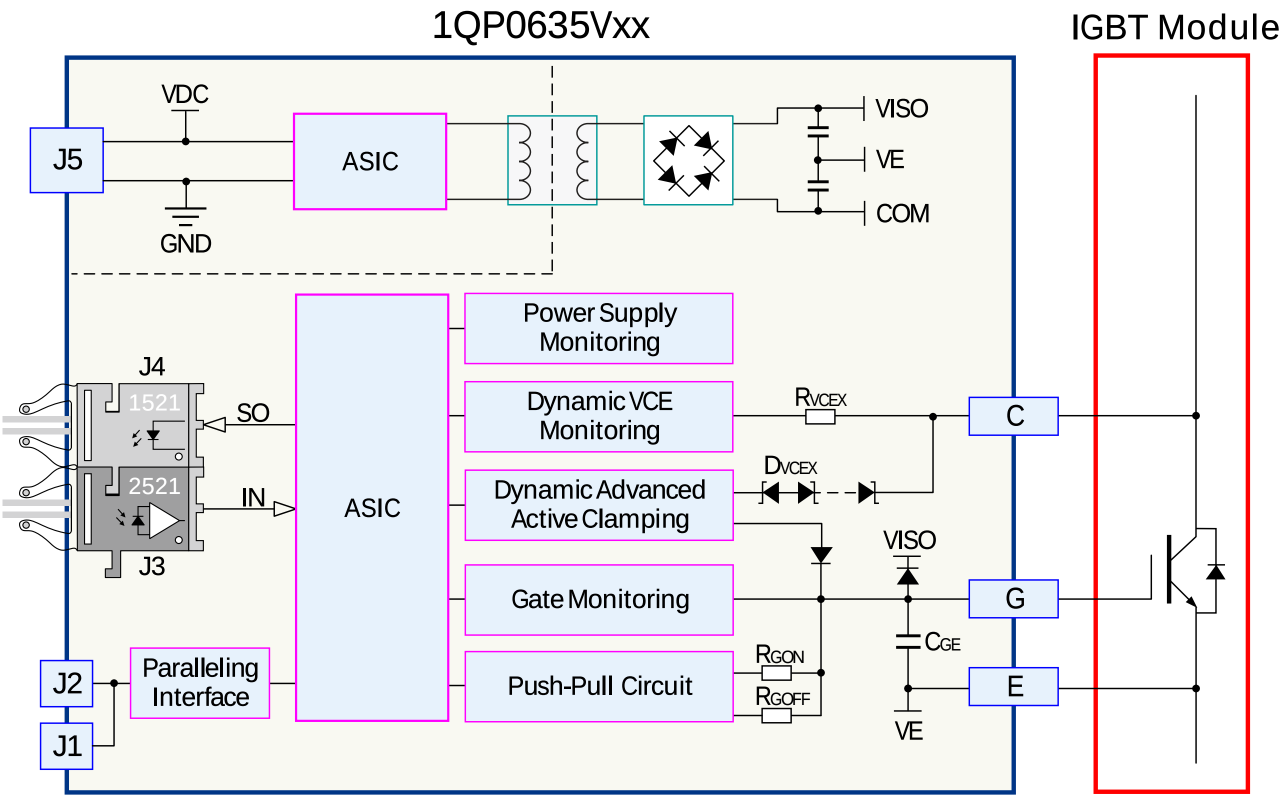


Figure 1. Block diagram of 1QP0635Vxx

Pin Designation

Fiber Optic Interfaces

Interface	Symbol	Description
J3	IN 1)	Signal input
J4	SO 2)	Status output

Note: 1) PWM input, receiver type: HFBR-2521Z from Broadcom.

2) Status output, transceiver type: HFBR-1521Z from Broadcom.

Connector J5 1) - Primary Side Interface

Pin	Symbol	Description	Pin	Symbol	Description
1	GND	Ground	3	VDC	+15V for DC/DC converter
2	VDC	+15V for DC/DC converter	4	GND	Ground

Note: 1) Connector type: 214012_ERNI.

Connector J1 1) - Secondary Side Parallel Connection

Pin	Symbol	Description	Pin	Symbol	Description
1	VISO	Positive secondary side power supply from master to slaves	4	COM	Negative secondary side power supply from master to slaves
2	COM	Negative secondary side power supply from master to slaves	5	N.C	No internal connection
3	G-15V	Drive signal from master to slaves	6	G-25V	Slave gate voltage detection signal

Note: 1) Connector type: 214013_ERNI.

Connector J2 1) - Secondary Side Parallel Connection

Pin	Symbol	Description	Pin	Symbol	Description
1	VISO	Positive secondary side power supply from master to slaves	4	COM	Negative secondary side power supply from master to slaves
2	COM	Negative secondary side power supply from master to slaves	5	N.C	No internal connection
3	G-15V	Drive signal from master to slaves	6	G-25V	Slave gate voltage detection signal

Note: 1) Connector type: 214013_ERNI.

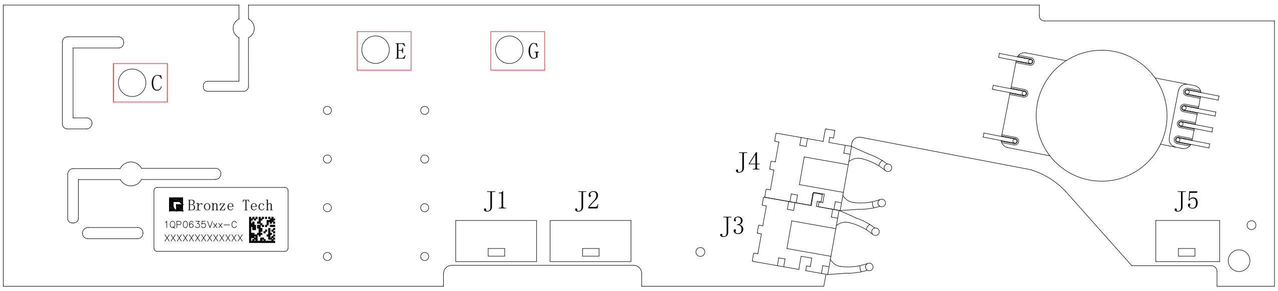


Figure 2. 1QP0635Vxx Pin layout

Function Description

Power Supply and Monitoring

The driver is equipped with a single-channel DC/DC power supply, which enables electrical isolation of the power supply and the gate drive circuit. The basic principle of the single-channel DC/DC power supply is shown in the block diagram of Figure 3.

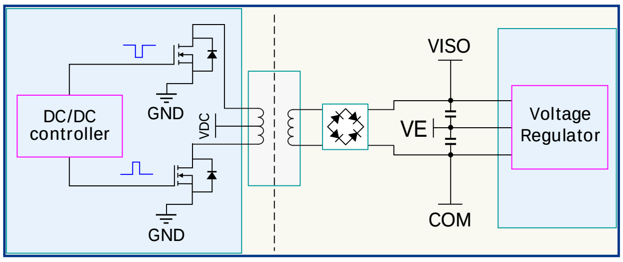


Figure 3. Power supply circuitry

Secondary Side Supply Monitoring:

On the secondary side the supply voltage VISO-COM is monitored and under-voltage protection is included. The secondary side supply voltage is closed-loop regulated, the amplitude of which however, may vary with load condition. The positive voltage is regulated with priority. When excessively heavy load is present, the full voltage V_{CCO} drops. When V_{CCO} reaches 18V, the under-voltage protection function is triggered and assert an under-voltage fault. The IGBT is turned off.

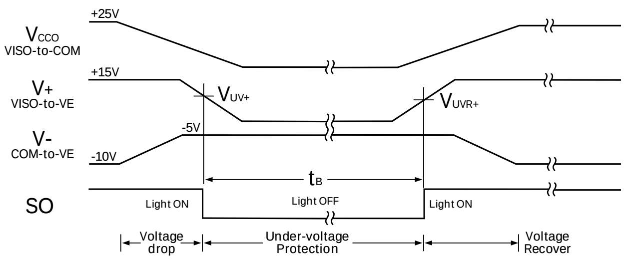


Figure 4. Secondary-side UVLO logic

Input Signal

The input signal IN is provided via the fiber optic connector. A light ON turns on the IGBT, while a light OFF turns it off.

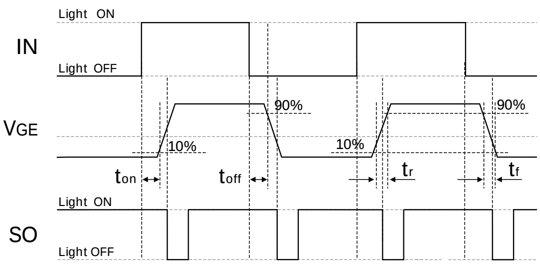


Figure 5. IN input circuitry

Status Output Signal

In normal operation, each edge of the input signal is acknowledged by the driver with a short SO pulse (the light is off for a period of 1200ns).

In the event of a short-circuit fault, the fault status is transferred to status output port, the light is driven off by 15us.

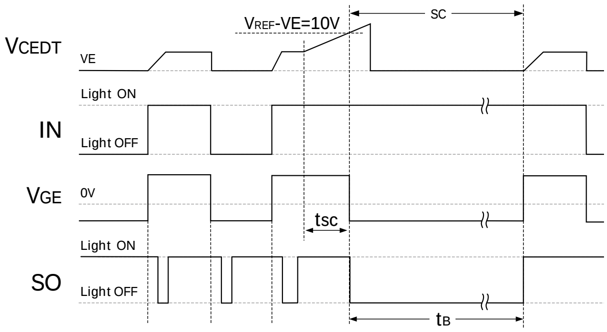


Figure 6. Protection signal output logic

IGBT Turn-on and Turn-off

To turn on the IGBT, Q_{ON} is turned on, Q_{OFF} is turned off, and then the gate resistor R_{GON} is pulled up to charge the IGBT gate.

To turn off the IGBT, Q_{OFF} is turned on, Q_{ON} is turned off, and the gate resistor R_{GOFF} is pulled down to discharge the IGBT gate.

For the selection of gate resistors R_{GON} and R_{GOFF}, users can consult our technical support for setting factory pre-configuration. When mounted on to the corresponding IGBT module, please make sure that the appropriate gate resistor has been assembled.

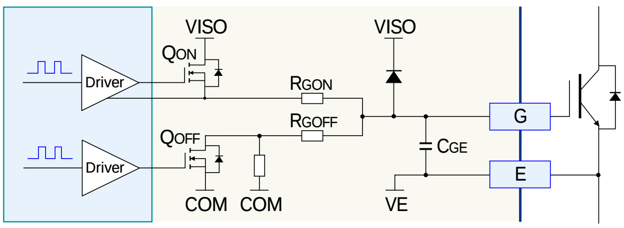


Figure 7. Gate drive output circuitry

Dynamic Active Clamping

Fast IGBT turn-off may lead to voltage spikes, which is critical when DC-link voltage and load current are high. Voltage spikes can cause damage to the IGBT. The turn-off voltage spike is mainly correlated to the stray inductance L_S and the slew rate of the IGBT turn-off current di/dt. By adjusting the turn-off gate resistor R_{GOFF}, di/dt can be reduced and the voltage overshoot is reduced. However, the impact of L_S is inevitable. It can be more pronounced under high current in short circuit or overload. The driver is equipped with dynamic active clamping function to effectively prevent the overvoltage damage on IGBT.

When active clamping is activated, the MOSFET Q_{OFF} is turned off in order to improve the effectiveness of the clamping and reduce the losses in the TVS.

Additional TVS has been added in series to the TVS required to withstand the maximum DC-link voltage under switching operation. This additional TVS is shorted by Q_{ACL} during the IGBT on state as well as a short interval after the turn-off to ensure effective clamping. After this interval of delay, Q_{ACL} is turned off and the additional TVS is activated, the allow the DC-link voltage be increased to a higher value than the clamping threshold (e.g. after emergency shut-down where the DC-link is charged up by the residual inductive load current).

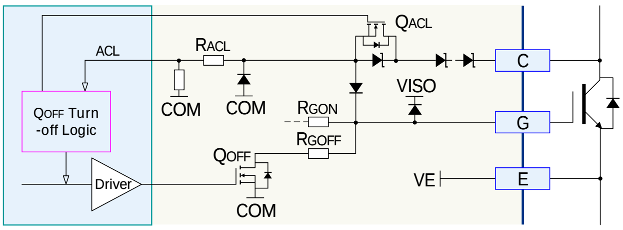


Figure 8. Dynamic active clamping circuitry

IGBT Short-Circuit Protection

The V_{CE} detection circuitry is used for IGBT short- circuit protection. The detection of two channels are independent from each other. The short-circuit detection is only valid when the IGBT is turned on. When the IGBT is in off state, the input signal turns on Q_{CEx} and clamps V_{CEDTx} to COMx. In this case, the comparator outputs logic low.

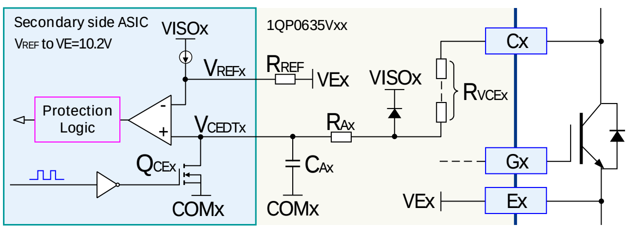


Figure 9. Short-circuit protection circuitry

Normal Turn-On:

When the logic input will turn on the IGBT, Q_{CE} is firstly turned off and releases the clamping of V_{CEDTx}. At this moment, IGBT is still in off state and V_{CE} is high. C_{Ax} capacitor is charged through the resistor chain composed of R_{VCEx} and R_{Ax}, V_{CEDTx} rises. Then the IGBT is turned on, V_{CE} quickly drops to saturation voltage $V_{CE\text{-}SAT}$ and V_{CEDTx} reaches $V_{CE\text{-}SAT}$.

As $V_{CE\text{-}SAT}$ is significantly lower than the protection threshold V_{REF}, the comparator does not flip over and the protection is not initiated.

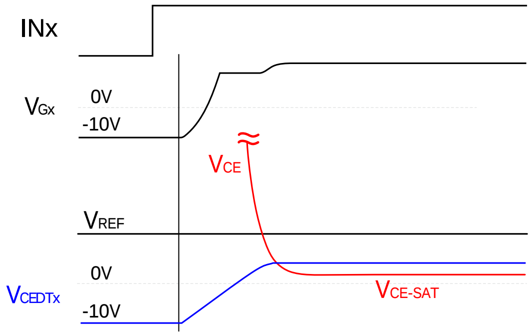


Figure 10. Signal waveform at normal turn-on

Class I Short- Circuit Protection:

When Class I short circuit (bridge shoot-through) occurs, due to the rapid increase of the short cirucit current, the IGBT desaturates and result in rapidly increased V_{CE}. C_{Ax} is charged and V_{CEDTx} rises until it is clamped at VISOx. During this process, V_{CEDTx} exceeds V_{REF} and the comparator's output flips, which consequently triggers the short-circuit protection.

The short-circuit protection logic turns off the IGBT immediately to ensure its safety. At the same time, set fault signal is sent to the primary side to light off the SOx, so as to alert a fault state. The channel is locked in fault state for a period t_B before recovering to the normal state.

The protection circuits of the two channels are independent from each other. Therefore, when short-circuit protection is initiated on one channel, the other channel remains operating normally. It is recommended to check the SOx signal timely and activate system lockout when necessary.

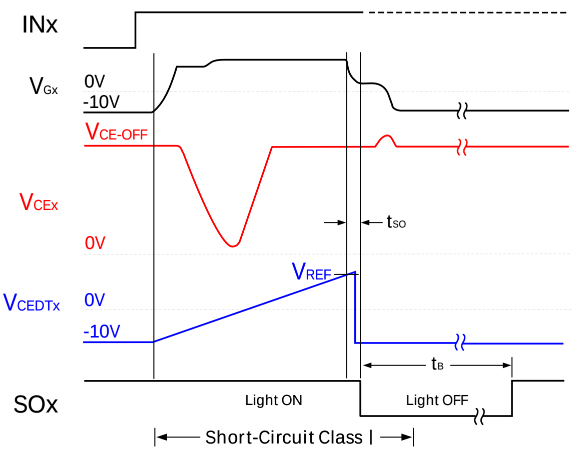


Figure 11. Class I short-circuit protection

Class II Short-Circuit Protection：

When a Class II short circuit (e.g. phase to phase short circuit) occurs, the current ramps up slowly as the loop is relatively high. The IGBT still enters saturation state normally. As the short-circuit current increases, V_{CE} increases gradually until it exceeds the protection threshold, then the driver initiate short-circuit protection. The response time in Class II short-circuit protection is longer than that of Class I.

In another case, If bridge shoot-through occurs under low DC-link voltage, the short circuit current is low and also resulting in increased protection response time.

Note: When a Class II short circuit occurs, the short circuit impedance varies greatly, which leads to uncertain timing of IGBT desaturation. Therefore, before the protection is initiated, the IGBT may have been already damaged by a considerable sum of heat accumulated. In this case, the driver's short-circuit protection cannot guarantee the intactness of the IGBT. Extra overcurrent protection measures have to be introduced.

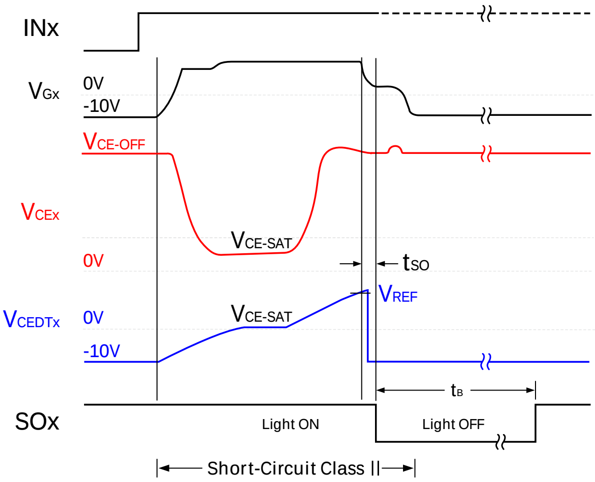


Figure 12. Class II short-circuit protection

Integrated Gate Monitoring

The driver is equipped with a gate monitoring function, where the mean value of all gate voltages (master and all slaves in parallel connection), V_{ge_mean}, is filtered and compared with the reference values at turn on and turn off, and if it exceeds the specified values ($V_{ge\_mean} < V_{GTH+}$ at turn on, $V_{ge\_mean} > V_{GTH-}$ at turn off), the driver will turn off all the parallel IGBTs and transmit the fault to the status output.

If one or more parallel drives are not switched on and off according to the reference value (drive signal input), the gate monitoring function will prevent the drive from operating.

Note: The gate monitoring function cannot be applied to slave drives that are not connected to the master drive via the parallel interface. In this case, the corresponding slave drives will not switch，and will not generate any gate monitoring faults.

Mechanical Dimensions

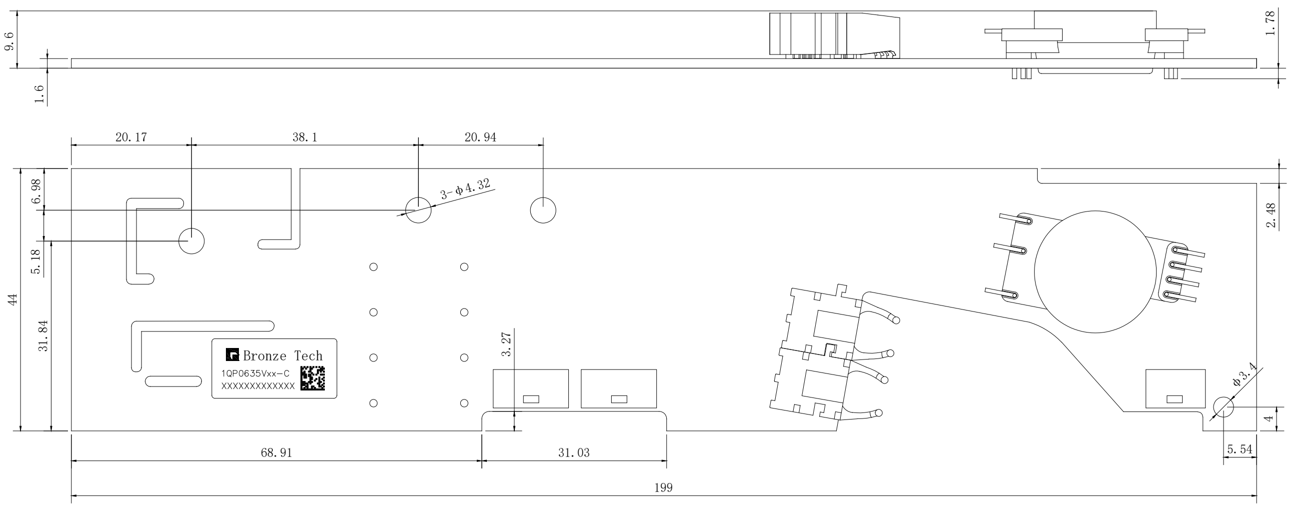


Figure 13. Mechanical drawing of 1QP0635Vxx

Note: 1)Legend unit: mm.

2)The margin tolerance conforms with the ISO 2768-1.

Revision History

REVISION	NOTES	DATE
V1.0	Intial release	25-May-2021
V1.1	Content optimized	01-Jun-2022
V1.2	Block diagram, pin designation, mechanical drawing and description updated.	21-Dec-2023
V1.3	Content and figures updated	01-Jul-2024

Precautions

- All operations on the IGBT module and driver shall conform with the electrostatic-sensitive device (ESD) protection requirements stipulated in IEC 60747-1/IX or EN100015.
- To protect ESDs, IGBT module and driver operation, including the operation sites and tools, must conform with these standards.

The IGBT and driver may be damaged due to negligence in ESD protection.

- Before powering on the driver, make sure that the driver and control board are connected correctly, without empty connection, false connection, or false soldering.
- After the driver is installed, its surface voltage to the ground may exceed the safety voltage. Therefore, do not touch it with bare hands.

Operations may involve life hazards. Be sure to follow the corresponding safety protocols !

DISCLAIMER

Bronze Tech Group | Shenzhen Bronze Technologies Ltd.

Website: www.qtjtec.com
Technical Support Tel.: +86 0755 33379866
Technical Support Email: support@qtjtec.com

Scan QR code to enter Bronze website.