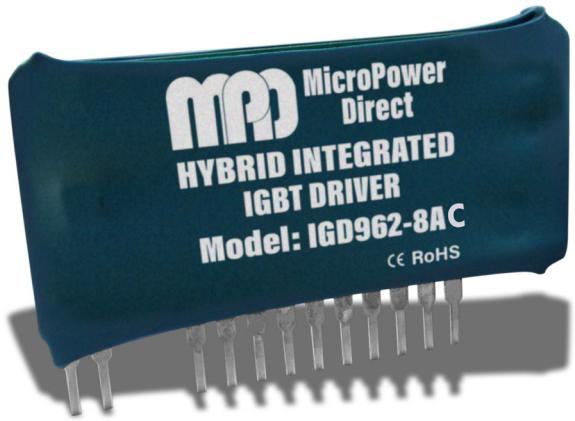
# IGD962-8AC

## Hybrid Integrated Isolated N-Channel IGBT Driver




### Key Features:

- Shielded OptoCoupler
- 30 kV/μS CMR
- Viso = 3,750 VAC
- ± 8A Output
- Two Supply Drive Topology
- TTL, CMOS Comp. Input
- Short Circuit Protected
- Fault Signal Output
- Switching Freq. to 40 kHz
- Compatible With M57962AL

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### Recommended For:

- 600V Series IGBT (up to 600A)
- 1200V Series IGBT (up to 400A)
- 1700V Series IGBT (up to 200A)

### Electrical Specifications

**Maximum Ratings,** $T_A$ = 25 ºC, $V_{CC}$ = 15 VDC, $V_{EE}$ = -10 VDC unless otherwise noted.

| Parameter | | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | | | | 18 | VDC |
| | $V_{EE}$ | | | | -15 | |
| Input Current, Between Pins 13 & 14 | $I_{IN}$ | During High Level Signal Status | | | 25 | mA |
| Input Voltage, Pin 1 | $V_{IN}$ | During High Level Signal Status | | 5.25 | 50 | VDC |
| Drive Output Voltage | $V_O$ + | When Input Signal is "High" | | | $V_{CC}$ | VDC |
| | $V_O$ - | When Input Signal is "Low" | | | $V_{EE}$ | |
| Output Current | $I_{GON}$ | Pulse Width: 2 μS | | | +8.0 | A |
| | $I_{GOFF}$ | Frequency ƒ = 20 kHz | | | -8.0 | |
| Isolation Voltage | $V_{ISO}$ | Sine Wave 50 Hz/ 60 Hz , For 60S with a Leakage Current <1 mA | | | 3,750 | VAC |
| Fault Output Current | $I_{FO}$ | Pin 8 Input Current | | | 20 | mA |
| Max Input Voltage to Fault Detect Pin | $V_{R1}$ | Pin 1 Input Voltage | | | 50 | VDC |
| Operating Temperature | $T_{OP}$ | | -40 | | +70 | ºC |
| Storage Temperature | $T_{ST}$ | | -50 | | +125 | ºC |

**Input Specifications**

| Parameter | | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Power Supply Input Voltage | $V_{CC}$ | DC Input, Recommended Range | 14 | 15 | | VDC |
| | $V_{EE}$ | | -7 | -10 | | |
| Input Current , Between Pins 13 & 14 | $I_{IH}$ | During High Level Signal Status | 10 | 16 | 20 | mA |

**Output Specifications**

| Parameter | | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Output Voltage | $V_{OH}$ | During High Level Signal Status | 13 | 14 | | VDC |
| Output Voltage | $V_{OL}$ | During Low Level Signal Status | -6 | -9 | | |

**General Specifications**

| Parameter | | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Switching Frequency | ƒ | Recommended Range | 0 | 20 | 40 | kHz |
| Gate Resistance | $R_G$ | | 2 | | | Ω |
| Turn-On Delay Time | $T_{PLH}$ | $V_{CC}$ = 15 VDC<br>$V_{EE}$ = -10 VDC<br>$I_{IH}$ = 16 mA<br>$R_G$ = 2Ω | | 0.4 | 1.0 | μS |
| Turn-On Rise Time | $T_R$ | | | 0.7 | 1.0 | μS |
| Turn-Off Delay Time | $T_{PHL}$ | | | 0.6 | 1.3 | μS |
| Turn-Off Fall Time | $T_F$ | | | 0.4 | 0.8 | μS |
| Threshold Voltage Protection | $V_{OCP}$ | $V_{CC}$ = 15 VDC, $V_{EE}$ = -10 VDC | | 9.2 | | VDC |
| Protection Reset Time | $T_{TIMER}$ | Duration, Start to End of Pro. Signal | 1.0 | 1.3 | 2.0 | mS |
| Fault Output Current | $I_{FO}$ | Pin 8 Input Current, R = 4.7 kΩ | | 5.0 | | mA |
| Short Circuit Detection Time | $T_{TRIP}$ | Pin 1 ≥ 15V, Pin 2 Open | | 2.6 | | μS |
| Soft Turn-Off Time | $T_{CF}$ | Pin 1 ≥ 15V | | 5.0 | | μS |
| Charge Quantity | $Q_G$ | $C_G$ = 160 nF<br>$R_G$ = 5Ω<br>$V_{CC}$ = 15 VDC<br>$V_{EE}$ = -10 VDC<br>ƒ = 20k (Total Power Spec Only) | | 3.4 | 4.0 | μC |
| Total Power | $P_{IN}$ | | | 3.4 | | W |
| Mechanical Dimensions | | See Mechanical Drawing on Page 4 | | | | |
| Weight | | 0.178 Oz (5.1g) | | | | |

**Notes:**
1. Exceeding Absolute Maximum Ratings may damage the module. These are not continuous operating ratings.
2. A user manual is available for this driver. For a copy, go to our website or call the factory.


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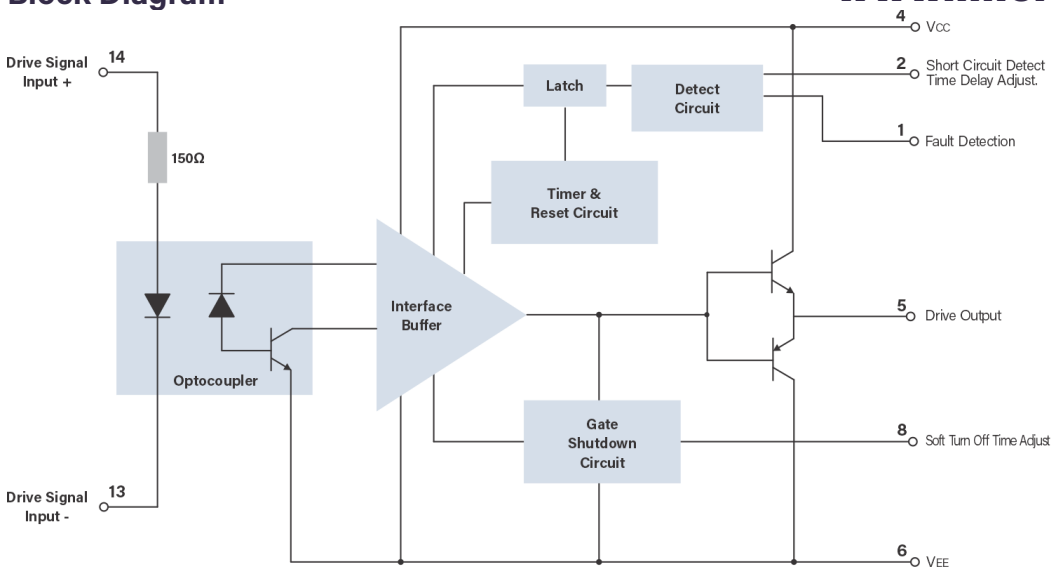
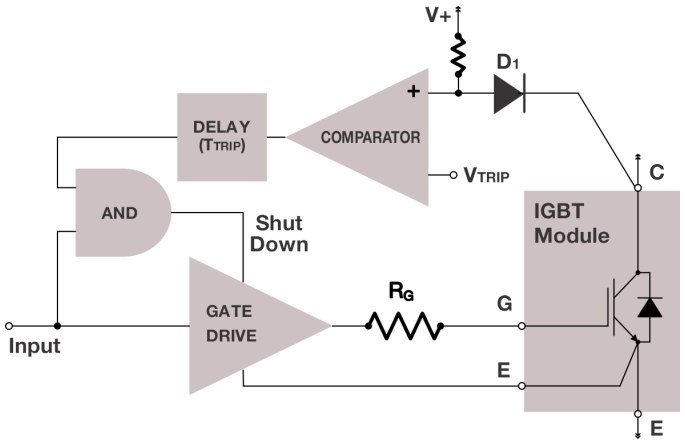
## Block Diagram




The **IGD962-8AC** is a hybrid integrated circuit designed to provide the isolated gate drive required for high power IGBT modules. It features an internal high speed optocoupler, high transient immunity, short circuit protection and a fault signal output. It is packaged in a compact single-in-line (SIP) package that minimizes the required printed circuit board space. The block diagram at left illustrates its' main components and features.

The **IGD962-8AC** converts logic level control signals into a fully isolated gate drive of +14V/-9.0V. Gate drive current is ±8A peak. Gate drive power isolation is provided by an external DC/DC converter (see connection diagram on page 3). Control signal isolation is provided by an internal high speed optocoupler. Desaturation detection is used for short circuit protection.

## Fault Detection Circuit

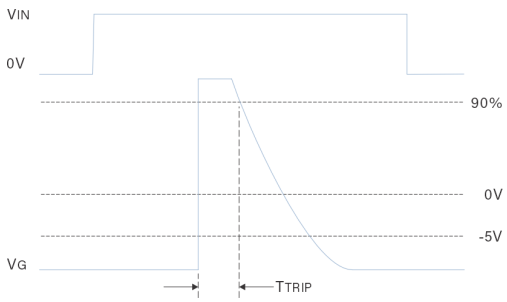



The **IGD962-8AC** provides short circuit protection by means of an on-state collector-emitter voltage sensing circuit. This type of protection is often called "Desaturation Detection". A block diagram of a typical desaturation detector is illustrated at left.

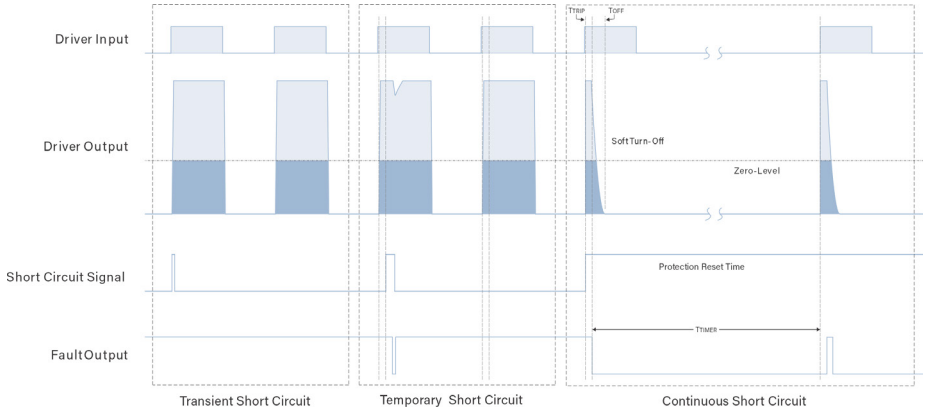
During a normal on-state condition, the comparator output will be low. During a normal off-state condition the comparator output will be high. If the IGBT turns on into a short circuit, the high current will cause it's collector-emitter voltage to rise above the level of VTRIP, even though the gate of the IGBT is being driven on.

This condition (a high VCE when the IGBT is supposed to be on) is often called desaturation. Desaturation can be detected by a logical AND of the driver input signal and the comparator output. When the output of the AND goes high a short circuit is indicated. The output of the AND is then used to command the IGBT to shut down.

## TTRIP Delay




## Fault Detection Waveforms




The TTRIP & fault detection waveforms above illustrate the response of the **IGD962-8A** to typical fault conditions. In the first block, an instantaneous or transient short circuit occurs.

To prevent false triggering of the fault detection circuit, there is a built in delay (TTRIP) during which it ignores the fault signal. This delay is provided after the comparator output (see desaturation block diagram above) to allow for the normal turn-on time of the IGBT.

The default delay is 2.32 $\mu$s, which will be sufficient for most applications. This can be increased by adding a capacitor (CTRIP) between pin 2 and pin 6 or a resistor (RTRIP) between pin 2 and pin 4. See page 4 for more information. The maximum allowable delay is limited by the IGBT's short circuit withstanding capability. The recommended limit for a typical application is 3.5 $\mu$s.

In block two, a temporary short circuit condition extends past the TTRIP limit (>2.32 $\mu$s) and triggers a shutdown. When an actual short circuit is detected (at the end of TTRIP), the driver provides a soft shut down. This will limit the transient voltage surge that occurs when large short circuit currents are interrupted. The default soft shutdown time is 5.0 $\mu$s, which should work for most applications.

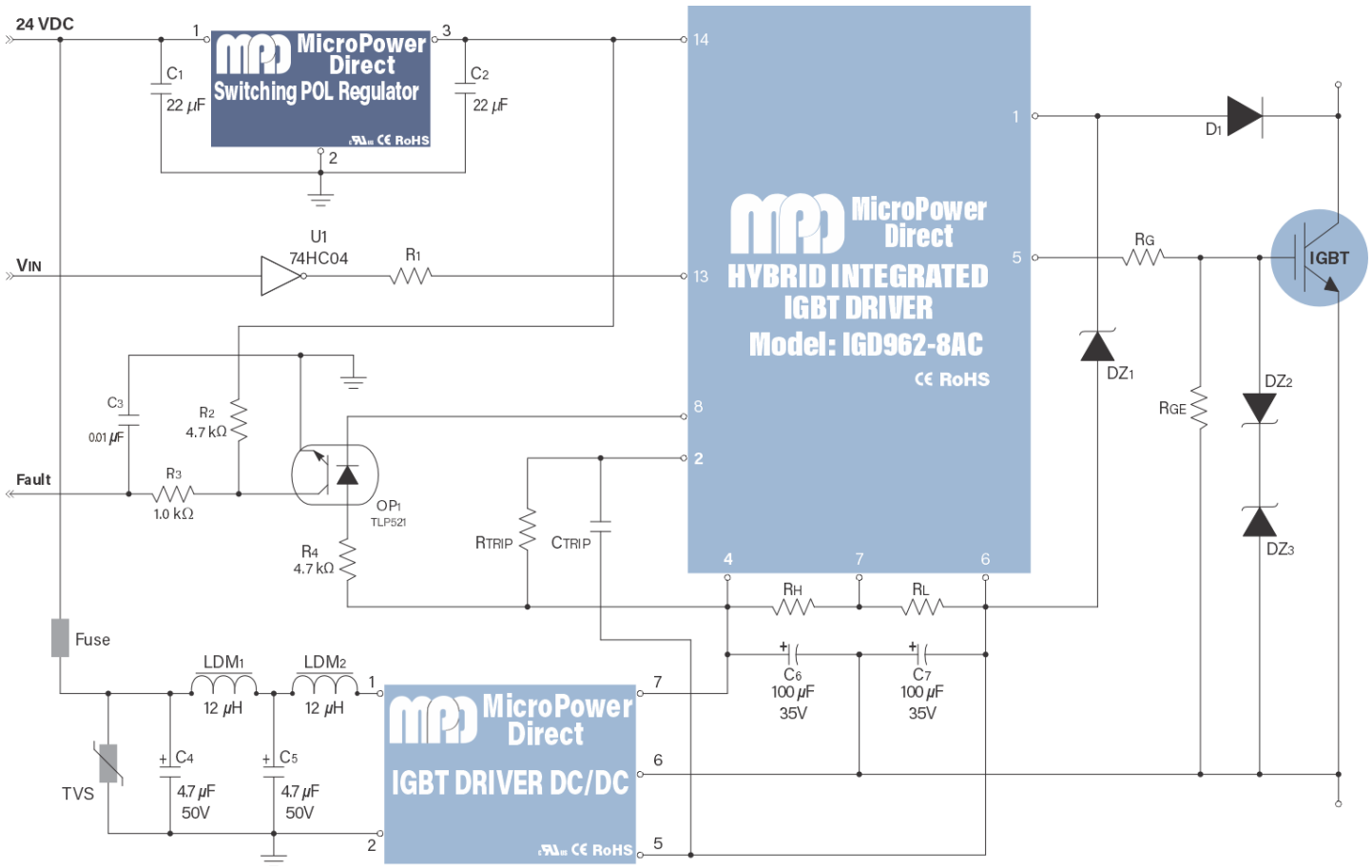
When the short circuit signal extends past TTRIP, a fault signal is generated (from pin 8 & OP1). At this time, the driver output will start to decay. In our example, the short circuit is only temporary. When the IGBT VCE returns to a normal level, the over current signal will go low. This causes the fault signal to return high and the driver output will start to recover.

In block three, the driver turns on into a continuous short circuit condition. As soon as TTRIP ends, the fault signal goes low (from pin 8 & OP1), and the IGBT is shutdown. The driver will try to turn the IGBT on again after 1.3 mS.

If the fault condition causing the short circuit is removed during the period of TTIMER, the unit will recover at that point and operate normally.

## Typical Connection






**Notes:**

To minimize the potential for problems (and/or failures) caused by induced noise or EMI interference; the connection of the gate driver must be done with great care. Some recommendations would include:

1 The **IGD962-8AC** requires an external supply to power its internal circuits and set up VCC and VEE. The DC/DC should be mounted as close to the IGBT driver as possible, to minimize the length of connecting board traces or wires.

The input fuse and TVS are recommended to provide protection against overload or transients that might occur on the power line (typical of most low power DC/DC's).

2. The addition of the input filter components (C4, C5, LDM1 & LDM2 ) will typically bring the circuit to within the limits of EN 55032 Class B. If meeting EN 55032 class B is not a concern, the inductors (LDMX) and C5 can be eliminated.

All input components should be mounted as close to the DC/DC as possible. The trace (or wire) between the DC/DC and the driver circuit should be as short as possible.

3. Low impedance electrolytic capacitors (C6 and C7) are used to decouple the supply outputs. These capacitors should be mounted as close to the **IGD962-8AC** driver as possible. To ensure peak gate current, these capacitors should have a low ESR rating. It is important that these components be selected for low impedance and the maximum allowable ripple current that is sufficient for the application.

4. Our circuit uses a low cost POL switching regulator to provide a stable 5V input signal voltage to the input (pin 14) of the **IGD962-8AC**. The input signal voltage cannot exceed 5.25V. The internal dissipation caused by the resultant increase in input current could damage the input optocoupler. A current limiting resistor (R1) is used to help prevent this. The resistor value is calculated by the formula:

$$R_{IN} = \frac{V_{IN} - 1.7}{I_{IH}} - 150\Omega$$

If we were using a 15V input for our circuit, the current limiting resistor would be equal to:

$$R_{IN} = \frac{15 - 1.7}{16\ mA} - 150V = 681\Omega$$

5. The gate wiring of the IGBT gate-emitter drive loop must be shorter than 1 meter.

6. Twisted pair wiring is recommended for the gate-emitter drive loop to minimize mutual induction.

7. If a large voltage spike is generated at the IGBT collector, the value of the gate resistor (RG) should be increased. The range of acceptable values for RG is 2Ω to 5Ω.

8. The peak reverse voltage rating of D1 must be higher than the peak value of the IGBT collector voltage.

9. The voltage level at pin 1 could go "High" depending on the reverse recovery characteristics of D1. A 30V zener diode DZ1 is connected between pin 1 and pin 6 to prevent any problems caused by this.

10. The **IGD962-8AC** has a short circuit detection time delay of 2.32 µS, sufficient for most applications. If required, this can be extended to 3.5 µS by connecting a capacitor (CTRIP) or a resistor (RTRIP). If used, these trim components should be mounted as close to the driver as possible (no more than 5 cm). See page 2 & 4 or contact the factory for details.

11. To help limit transient voltage surges that could occur if a short circuit is interrupted, a soft shutdown is provided by the driver. The default time (TOFF) is 5 µS.

12. If the **IGD962-8AC** short circuit protection is activated, it will immediately shut down the gate drive and pull pin 8 low to indicate a fault (via OP1). During normal operation, the collector of OP1 is pulled high by R2. In the event of a fault, the driver output is disabled and a fault signal is produced that lasts a minimum of 1 mS (TTIMER). The RC filter (C3 and R3) help provide noise immunity. If the short circuit protection circuit is not used, these components can be eliminated and pin 8 should be left open.

13. If the short circuit protection circuit is not used, a 4.7 kΩ should be connected between pin 1 and pin 6 (D1 and DZ1 are not required with this configuration).

## Short Circuit Detection Time Trims

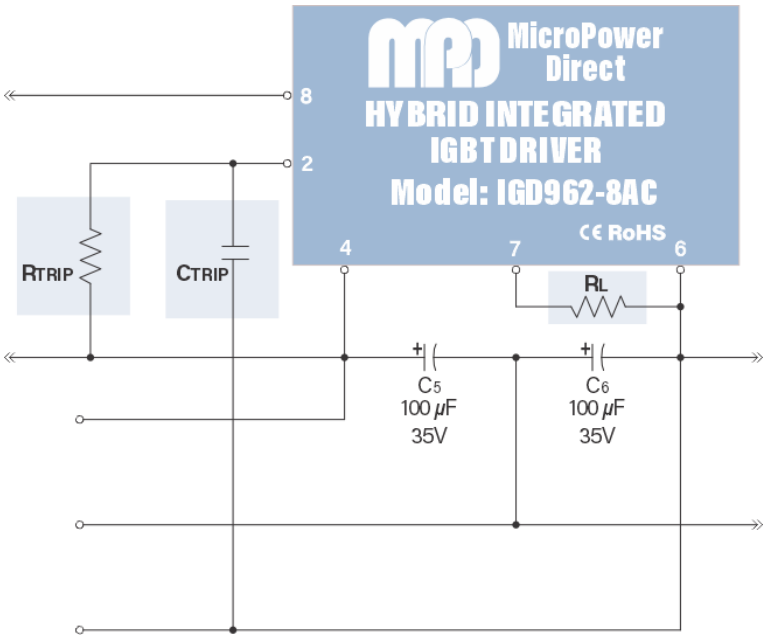



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Table 1
SC Detection Time
Vs CTRIP & RTRIP

| CTRIP | RTRIP | TTRIP |
|---|---|---|
| --- | 20 kΩ | 1.80 µS |
| --- | 51 kΩ | 2.06 µS |
| --- | --- | 2.32 µS |
| 4.7 nF | 20 kΩ | 2.34 µS |
| 4.7 nF | 51 kΩ | 2.74 µS |
| 10 nF | 20 kΩ | 3.14 µS |
| 4.7 nF | --- | 3.16 µS |

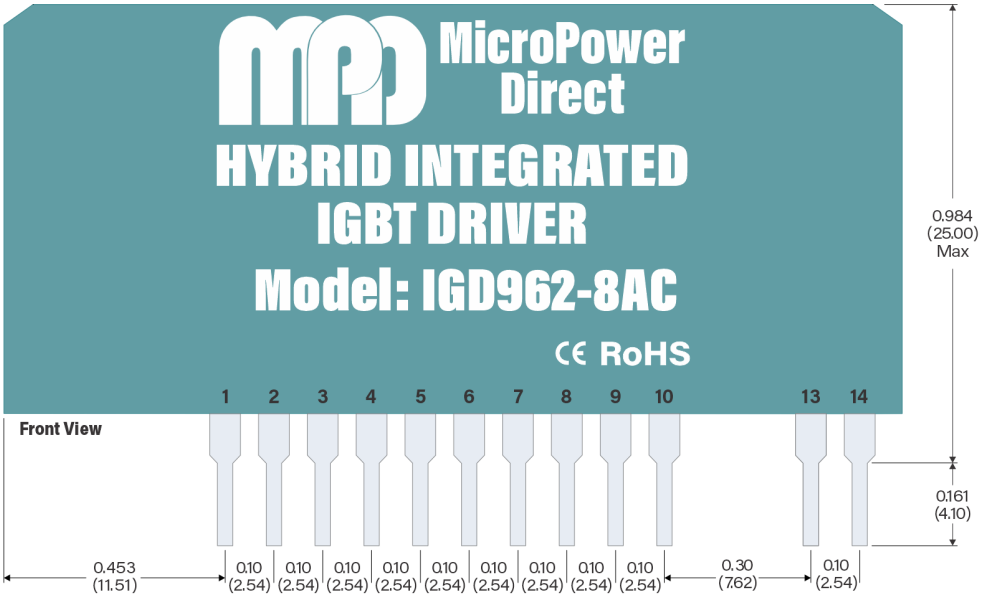
Table 2
Over Current Threshold Voltage
And TTRIP Vs RL & RH

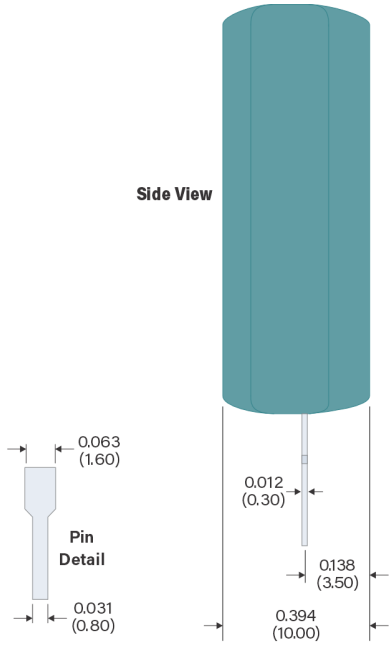
| RL | RH | VOCP | TTRIP |
|---|---|---|---|
| 51 kΩ | --- | 8.0V | 1.90 µS |
| 100 kΩ | --- | 8.5V | 2.18 µS |
| 150 kΩ | --- | 8.8V | 2.22 µS |
| --- | --- | 9.4V | 2.32 µS |
| | 24 kΩ | 10.0V | 2.42 µS |
| --- | 12 kΩ | 10.5V | 2.52 µS |

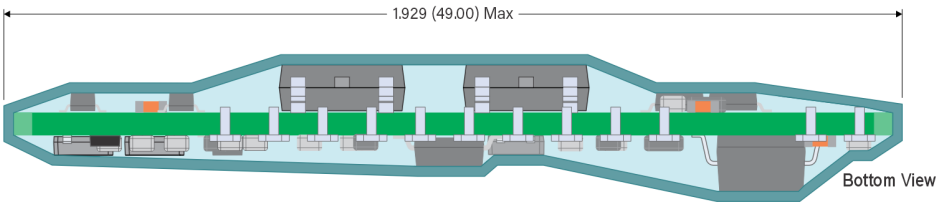
The **IGD962-8AC** provides trims to adjust the timing of the short circuit detection circuit (TTRIP). The trims RTRIP and CTRIP adjust the time span of TTRIP. The short circuit detection time delay can be adjusted down to 1.80 µS, it should not be adjusted over 3.5 µS. The circuit conditions for Table 1 are VCC = 15V, VEE = -10V, switching frequency = 25 kHz and RG = 2Ω.

The trims RL and RH adjust the level of the over current protection threshold voltage VOCP (VTRIP in the desaturation detection block diagram on page 2). This is done by adjusting VCC or VEE with the trims RH and RL. Increasing VCC raises VOCP. Decreasing VEE lowers VOCP. The range of the adjustment should be within 8.0V to 10.5V. The circuit conditions for Table 2 are VCC = 15V, VEE = -10V and switching frequency = 25 kHz.

## Mechanical Dimensions




| Pin | Function | Pin | Function |
|---|---|---|---|
| 1 | +VDD (+ Power Supply) | 10 | DC/DC Output (-) |
| 2 | -VDD (- Power Supply) | 11 | Drive Output |
| 3 | Drive Signal Input (+) | 12 | Internal Power Tube |
| 4 | Drive Signal Input (-) | 13 | Fault Detection |
| 7 | Threshold Volt Adjust | 14 | Soft Turn-Off Adj |
| 8 | DC/DC Output (+) | 15 | Fault Signal Output |
| 9 | DC/DC Output (Comm) | 16 | Control Pin (ForTTRIP) |

**Notes:**

- All dimensions are typical in inches (mm)
- Gen. Tolerance x.xx = ±0.02 (±0.50)
- Pin Tolerance x.xx = ±0.004 (±0.10)
- Recommended pin hole size (on the application PC Board) is Ø 0.051 (Ø 1.30)
- Pins 3, 9 and 10 have no external function. They may be used by the factory for production testing. They should be left floating.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