

International Rectifier  
El Segundo, California

# **PROVISIONAL SPECIFICATION FOR THE GENERIC DOL POWER MODULE 11867-E02**

Document : EN-0630, Rev. 01

Page 1 of 10

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The technical content of this document is the responsibility of the  
El Segundo Automotive Systems Department 9810

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## Table of Contents

<b>TITLE PAGE .....</b>	<b>1</b>
<b>TABLE OF CONTENTS .....</b>	<b>2</b>
<b>0 PURPOSE .....</b>	<b>3</b>
<b>1 SCOPE .....</b>	<b>3</b>
<b>2 APPLICABLE DOCUMENTS .....</b>	<b>3</b>
<b>3 DEFINITIONS/TERMS .....</b>	<b>3</b>
<b>4 RESPONSIBILITY/AUTHORITY .....</b>	<b>3</b>
<b>5 TOOLS/EQUIPMENT/MATERIALS .....</b>	<b>3</b>
<b>6 PROCEDURE/SPECIFICATION .....</b>	<b>3</b>

## **0 Purpose**

This document establishes the Specification for the Generic DOL Power Module 11867-E02

## **1 Scope**

This document defines the electrical characteristics and specifications for the Generic DOL Power Module 11867-E02.

## **2 Applicable Documents**

EN-0244	Power Module (Drawing)
EN-0345	Schematic Diagram
01-5653	IRFC1404Z Die Outline Drawing

## **3 Definitions/Terms**

Not Applicable.

## **4 Responsibility/Authority**

The department 9810 is responsible for the technical content of the document.

## **5 Tools/Equipment/Materials**

Not Applicable.

## **6 Procedure/Specification**

See attached document.

## Provisional Specification for the Power Module 11867-E02

### F Application

The module's application is to supply power to the trapezoidal brushless DC motor in Electric and Hydraulic Electric Power Steering (EPS and HEPS) systems, by switching power to the three phases of the motor.

### B Module Characteristics/Components

$T_{\text{ambient}} = 25^{\circ}\text{C}$  unless otherwise specified.

- The electric circuit schematic is shown in schematic diagram EN-0345.
- With reference to the electrical circuit schematic, the reference designators of the inverter die are UH (Q1), VH (Q3), WH (Q5), UL (Q2), VL (Q4) and WL (Q6) – HEX 3.2, 40V (IRFC1404Z).
- Electrical interfaces to battery  
The module gets battery power through B+ and GND terminals. All current switched to the motor by the power module is supplied from these terminals. Power module physical outline is shown in EN-0244.
- Electrical interface to the three phases of the motor.  
The module's terminals U, V, and W, provide the electrical interface with the three phases of the motor.
- Electrical interface to the control circuitry.  
The electrical interface between module and control board is achieved through fourteen pins. Pin designation is shown in the electrical schematic EN-0345 and the Power Module drawing EN-0244.
- Mounting features.  
The power module is to be mounted using a thermally conductive adhesive and screws between the module and the steering housing.
- Current Sense Resistor  
Current sensing is achieved through a low inductance, 0.3 m $\Omega$  shunt resistor, which is connected between the ground terminal GND and the source of 3 Low side MOSFETs. Accuracy of the current sense resistor is +/- 1%. Accuracy of the current signal will be based on characterization results upon customer approval. Current sense resistor value is not fixed. Upon customer request and IR approval, modules with different current resistor values (i.e. 0.5 m $\Omega$ , 0.7 m $\Omega$ , 1 m $\Omega$ ) can be provided.
- Temperature sensor  
One NTC Thermistor positioned beside a MOSFET, provides a temperature reading that can be correlated to the Junction temperature of that MOSFET. The NTC Thermistor is 10K $\Omega$  @25 $^{\circ}\text{C}$  +/-5% with a B-value 3380K @25 $^{\circ}\text{C}$  +/-3%. Upon customer request and IR approval, modules with different thermistor values can be provided.

## C Handling Recommendations

The Power Module 11867-E02 is an ESD (Electro Static Discharge) sensitive device. It should be handled in accordance with "IEC 61340-5-1 Electrostatics- Part 5-1: Protection of electronic devices from electrostatic phenomena- General requirements" and "IEC 61340-5-2 Electrostatics- Part 5-2: Protection of electronic devices from electrostatic phenomena- User Guide" "IEC" is the "International Electrotechnical Commission". These documents are equivalent to the European Standard (EN) and the British Standard (BS) of the same numerical designation.

These are standards that describe the special requirements and precautions needed when handling ESDS (Electro Static Discharge Sensitive) devices.

The Power Module 11867-E02 is built with large FET's when compared with typical discrete components. These large FET's also provide improved ESD performance versus the typical discrete components.

The Power Module 11867-E02 provides ESD performance above 2 kV against the Human Body Model (HBM; 100pF, 1500 $\Omega$ ), above 2 kV against the Machine Model (200pF, 0 $\Omega$ ), and 2 kV against the Charge Device Model.

#### D. Electrical Specifications

The following electrical ratings are applicable at module package unless otherwise specified.

Parameter		Conditions *(Note 1)	Min	Typ	Max	Unit	
I <sub>out U, V, W pk</sub>	Maximum Phase Current	T <sub>c</sub> = 100°C 33% DC, no modulation	-	100	TBD	A	
		T <sub>c</sub> = 100°C ON time = 6ms max Full conduction with 16kHz modulation	-	130	TBD	A	
I <sub>B+ to GND</sub>	Input Current (RMS)	Continuous	-	-	120	A	
V <sub>B+ to GND</sub>	Input Voltage	Continuous	-	-	40	V	
V <sub>gs</sub>	Gate to Source Voltage	---	-20	-	20	V	
V <sub>th</sub>	Threshold Voltage	Inverter HexFET's	T <sub>j</sub> = -40°C	-	-	V	
			T <sub>j</sub> = 25°C	TBD	3.55	TBD	V
			T <sub>j</sub> = 175°C	-	-	-	V
R <sub>DS(ON)</sub>	Inverter FET High Side (UH, VH, WH) (See *Note 2)	V <sub>GS</sub> = 10V I <sub>D</sub> = 130A T <sub>j</sub> = 25°C	TBD	1.7	TBD	mΩ	
R <sub>DS(ON)</sub>	Inverter FET Low Side (UL, VL, WL) (See *Note 2)	V <sub>GS</sub> = 10V I <sub>D</sub> = 130A T <sub>j</sub> = 25°C	TBD	1.7	TBD	mΩ	
BV <sub>DSS</sub>	Inverter FET (UH, UL, VH, VL, WH, WL)	V <sub>GS</sub> = 0 I <sub>D</sub> = 250μA	TBD	44	TBD	V	
V <sub>iso</sub>	Isolation Voltage (Case-to-Connector)	1 second 50/60Hz Leakage Current < 2mA	600	-	-	VAC	
Total loop resistance B+ -> GND with U, V, and W shorted a 0.3mΩ is included in the low side leg		V <sub>GS</sub> = 10V I <sub>D</sub> = 130A T <sub>j</sub> = 25°C		5.6	TBD	mΩ	

**\*Note 1.** - Maximum currents ratings are specified at the following conditions in conformance to customer's specifications:

$$V_{B+ to GND} = 13.5V$$

$$V_{gs} = 10V$$

$$f_c = 16KHz$$

$$PWM = 0 to 100\%$$

$$ETS = 1.3mJ$$

**\*Note 2.** -See page 9 for Kelvin sense locations. Minimum and maximum limits are temporary. They will be defined once full characterization of the power module will be completed.

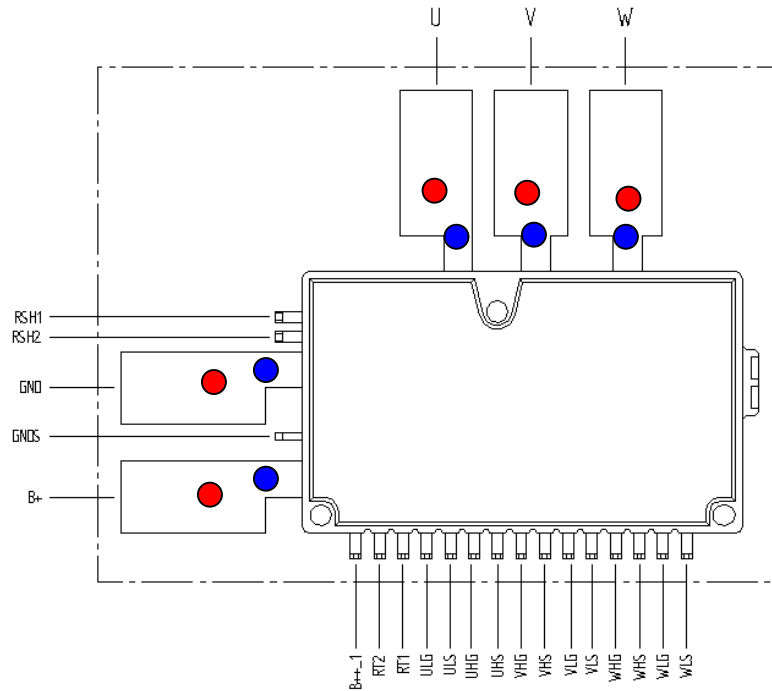
**E. Thermal Properties**

Parameter		Min	Typ	Max	Unit
$R_{thjc}$	Thermal Resistance Junction to Case, Single Inverter FET (*Note 3)	-	0.6	0.9	°C/W
$T_j$	Maximum Junction Temperature	-		175	°C
$T_c$	Operating Case Temperature	-40		100	°C
$T_{stg}$	Storage Temperature	-40		125	°C

\* **Note 3** - These values are based on numerical simulations, not empirical data. They will be updated once full characterization of the power module will be completed.

## F. Resistance Measurements Methods

### Force and sense points for power module resistance measurements

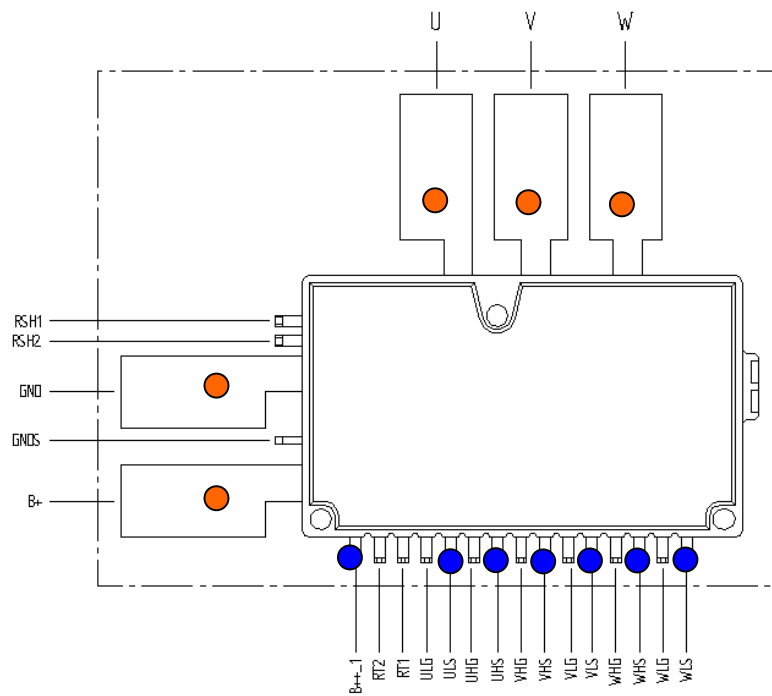


● Force points  
 ● Sense points

	+ Force	- Force	+ Sense	- Sense		+ Force	- Force	+ Sense	- Sense
<b>UH path</b>	B+	U	B+	U	<b>UL path</b>	U	GND	U	GND
<b>VH path</b>	B+	V	B+	V	<b>VL path</b>	V	GND	V	GND
<b>WH path</b>	B+	W	B+	W	<b>WL path</b>	W	GND	W	GND



### Force and sense points for MOSFET Rds(on) resistance measurements



- Force points
- Sense points

	+ Force	- Force	+ Sense	- Sense		+ Force	- Force	+ Sense	- Sense
<b>UH</b>	B+	U	B++_1	UHS	<b>UL</b>	U	GND	UHS	ULS
<b>VH</b>	B+	V	B++_1	VHS	<b>VL</b>	V	GND	VHS	VLS
<b>WH</b>	B+	W	B++_1	WHS	<b>WL</b>	W	GND	WHS	WLS

