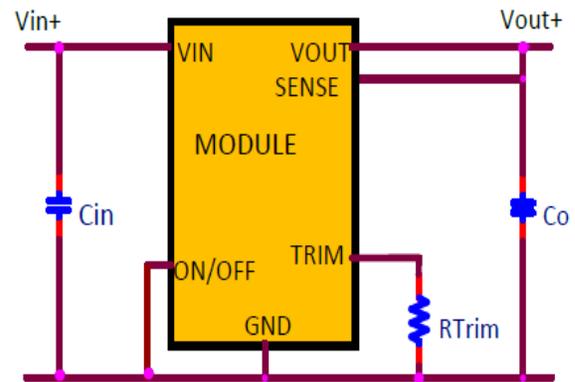


## DATASHEET

# IND016 Hornet: Non-Isolated DC-DC Voltage Regulator Modules

12V<sub>dc</sub> input; 1.0V<sub>dc</sub> to 5.5V<sub>dc</sub> output; 16.5W Max Power



## Applications

- Industrial Equipment
- Control Boards
- Test Equipment

## Electrical Features

- 12V Input voltage with up to  $\pm 20\%$  Tolerance
- Output voltage programmable from 1.0V<sub>dc</sub> to 5.5V<sub>dc</sub> via external resistor
- Remote On/Off for optional external control
- Fixed switching frequency
- Output overcurrent protection (non-latching)

## Mechanical Features

- Small size: 12.2 mm x 12.2 mm x 6.25 mm (0.48 in x 0.48 in x 0.246 in)
- Operating range: -40°C to 105°C ambient
- Operating shock to 40G per Mil Std. 810G, Method 516.4 Procedure I
- Operating vibration per Mil Std. 810G, Method 514.5 Procedure I

## Process and Safety

- Qualified for 1000h High Temperature Operating Bias, 1000h 85RH/85°C Temperature, Humidity and Bias, 700 cycle -40 to 125°C thermal cycling.
- ANSI/UL\* 62368-1 and CAN/CSA† C22.2 No. 62368-1 Recognized, DIN VDE‡ 0868-1/A11:2017 (EN62368-1:2014/A11:2017)
- ISO\*\* 9001 and ISO 14001 certified manufacturing facilities.
- Compliant to RoHS Directive 2011/65/EU and amended Directive (EU) 2015/863
- Compliant to REACH Directive (EC) No 1907/2006
- Compatible in a Pb-free or SnPb reflow environment.
- Suitable for aqueous clean.
- Suitable for conformal coating with dip and vapor deposition. Conformal coating can provide the protection to meet Salt Fog Test per IEC 60068-2-52 (Severity 3) and Mixed Gas Flow test per Telcordia GR-3108 Outdoor Levels.
- 3 year warranty.

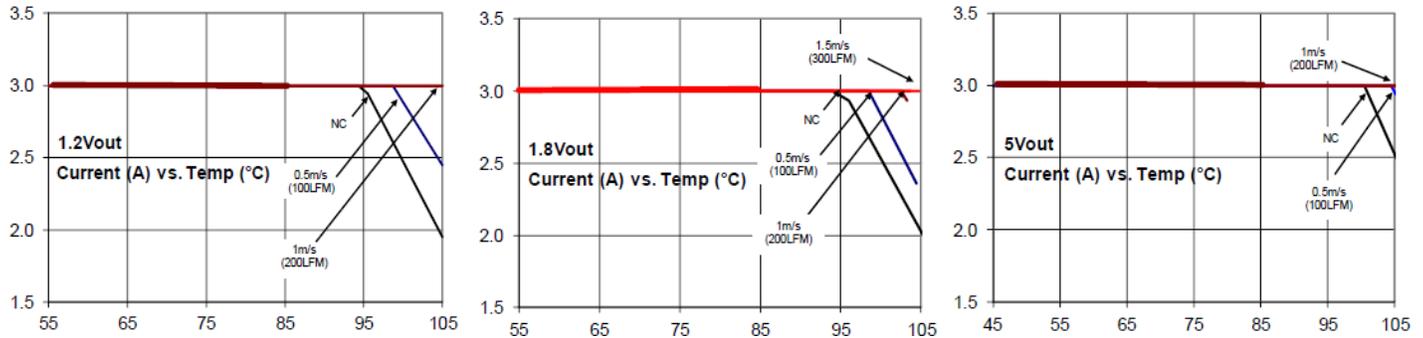
# Technical Specification

## Process and Safety (continued)

Device Code	Input Voltage	Output Voltage	Output Current (Max.)	On/Off Logic	Ordering Code
IND016	9.6 – 14.4**V <sub>dc</sub>	1.0 – 5.5V <sub>dc</sub>	3A	Negative	1600102897A

## Thermal Performance

Full rated output with natural convection up to 94°C at 1.2V<sub>out</sub> and up to 100°C at 5V<sub>out</sub>.. Thermal curves for 1.2V, 1.8V, and 5 V<sub>out</sub> below.



## Electrical Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	All	V <sub>IN</sub>	9.6	12	14.4**	V <sub>dc</sub>
Input No Load Current (V <sub>IN</sub> = 12.0V <sub>dc</sub> , I <sub>o</sub> = 0, module enabled)	V <sub>o,set</sub> = 5V <sub>dc</sub>	I <sub>IN,No load</sub>		38		mA
External Capacitance, Ceramic ESR ≥ 1 mΩ	All	C <sub>O,max</sub>	10	-	22*	μF
Efficiency 12V <sub>INDC</sub> , T <sub>A</sub> =25°C, I = 12A, V <sub>o</sub> = 1.2 to 5V <sub>dc</sub>		η	82.8(1.2V), 88.2(1.8V), 91.6(3.3V), 93.9(5V)			%
Switching Frequency	All	f <sub>sw</sub>	-	600	-	kHz
Output Voltage (Over all line, load, and temperature conditions)	All	V <sub>o,set</sub>	-3.0	-	+3.0	% V <sub>o,set</sub>
On/Off Logic High (MODULE OFF) Input High Voltage	All	V <sub>IH</sub>	3.0	-	14.4	V <sub>dc</sub>
On/ Off Logic Low (MODULE ON) Input Low Voltage	All	V <sub>IL</sub>	-0.2	-	0.4	V <sub>dc</sub>
PGOOD (Power Good)						
Singal Interface Open Drain, V <sub>supply</sub> ≤5V <sub>DC</sub>						
Overvoltage threshold for PGOOD				112.5		% V <sub>o,set</sub>
Undervoltage threshold for PGOOD				87.5		% V <sub>o,set</sub>
Pulldown resistance of PGOOD pin	All			30		Ω
Sink current capability into PGOOD pin	All				5	mA

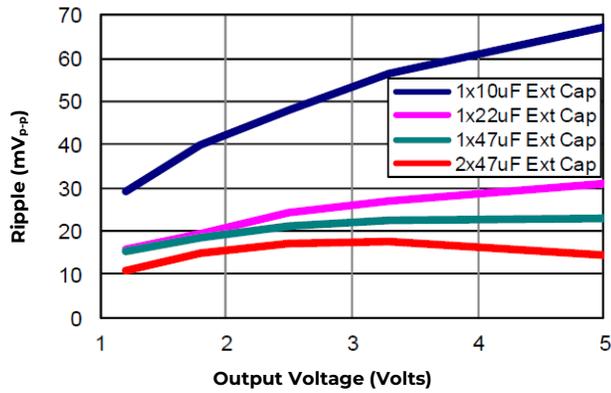
\*Additional External Capacitance possible using Tunable Loop

\*\* For 1≤V<sub>out</sub><1.1, do not exceed 12Vin. For 1.1≤V<sub>out</sub>≤1.2, do not exceed 13Vin. For V<sub>out</sub>>1.2, Input Voltage can be as high as 14.4V

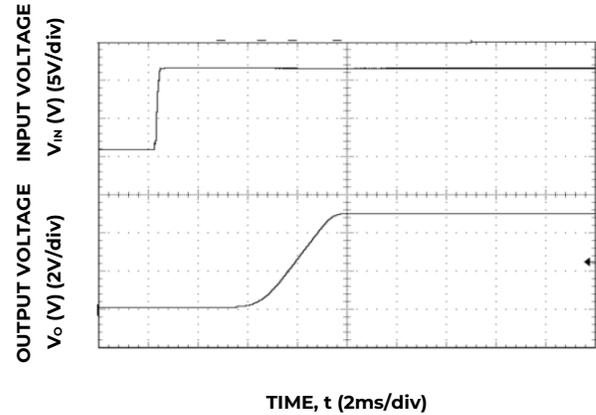
## Technical Specification (continued)

### Characteristic Curves

The following figures provide typical characteristics for the IND016 Hornet at 25°C.



**Figure 1. Output Ripple Voltage for various output voltages and external caps @12Vin. Additional Decoupling cap of 0.01uF used on input and output side**



**Figure 2. Typical Start-up using Input Voltage (Vin=12V, Vout = Vout, max, Iout = Iout, max)**

### Trim

Without an external resistor between Trim and GND pins, the output of the module will be  $0.6V_{dc}$ .  $R_{trim}$  for a desired output voltage, should be as per the following table. The formula in the last column helps determine  $R_{trim}$  for other voltages.

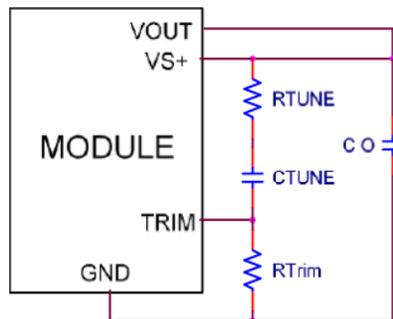
$V_o$ (V)	1.2	1.5	1.8	2.5	3.3	5.0	$R_{trim} = \left[ \frac{12}{(V_o - 0.6)} \right] k\Omega$
$R_{trim}$ (k $\Omega$ )	20	13..	10	6.316	4.4	2.727	

### Safety Considerations

For safety agency approval, the power module must be installed in compliance with the spacing and separation requirements of the end-use safety agency standards listed on the first page of this document. For the converter output to be considered meeting the requirements of safety extra-low voltage (SELV) or ESI, the input must meet SELV/ESI requirements. The power module has extra-low voltage (ELV) outputs when all inputs are ELV. The input to these units is to be provided with a fast-acting fuse with a maximum rating of 8A in the positive input lead.

### Tunable Loop

The module is designed for 1X47uF capacitor on its output. For applications where more than 1X47uF capacitors would be used on the output, an additional Resistor ( $R_{tune}$ ) and Capacitor ( $C_{tune}$ ) would be required in the circuit schematic to compensate for the additional capacitance. The placement is between the Sense+ pin and Trim pin as per figure below:



**Figure 3. Circuit diagram showing connection of  $R_{TUNE}$  and  $C_{TUNE}$  to tune the control loop of the module**

## Technical Specification (continued)

### Tunable Loop (continued)

The recommended values for  $R_{TUNE}$  and  $C_{TUNE}$  for different amounts of external capacitance are as per the table below:

Co	1x47 $\mu$ F	2x47 $\mu$ F	4x47 $\mu$ F	6x47 $\mu$ F	10x47 $\mu$ F
$R_{TUNE}$	270	220	180	180	180
$C_{TUNE}$	1500pF	1800pF	3300pF	4700pF	4700pF

### PowerGood (PGOOD)

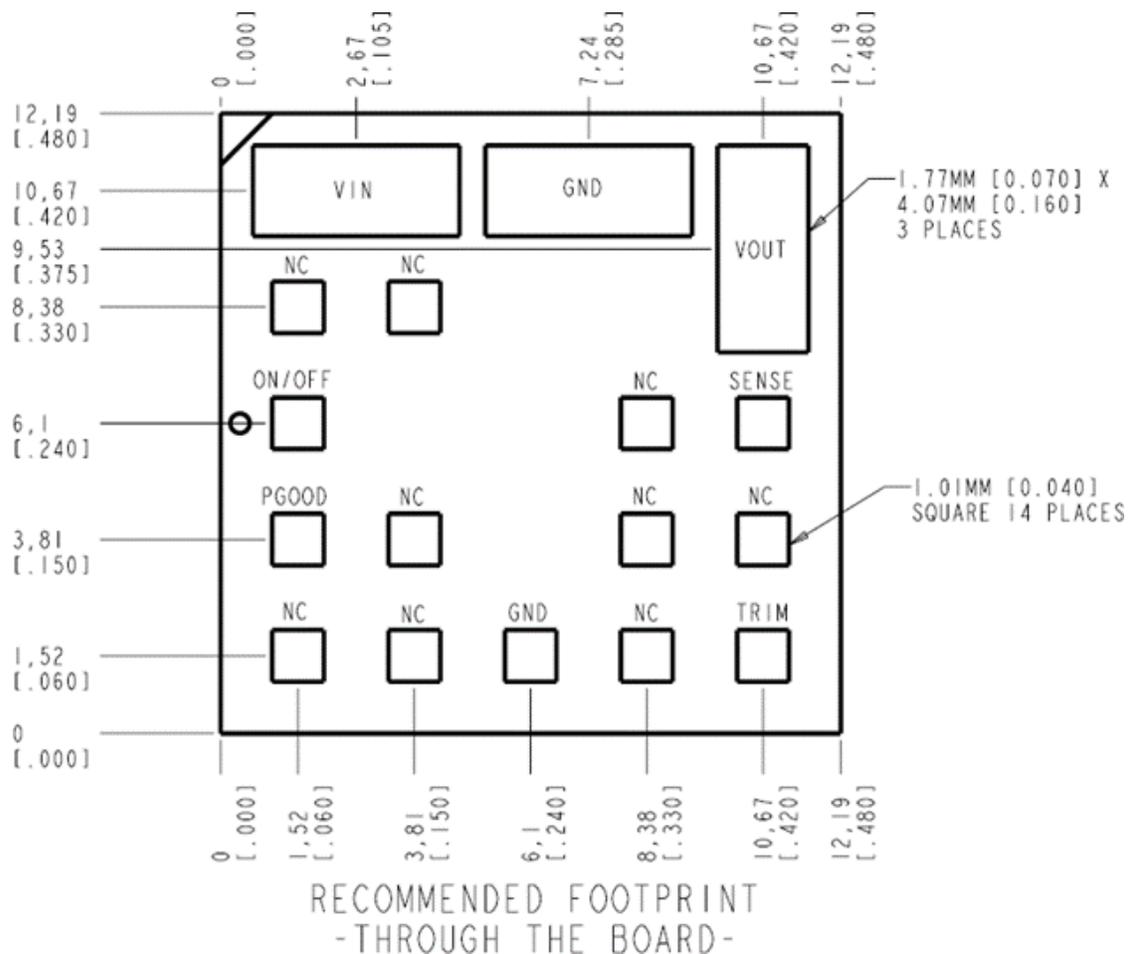
This is an open-drain output to indicate that the output voltage is within the regulation limits of the module. The PGOOD signal will be de-asserted to a low state if any condition such as overtemperature, overcurrent or loss of regulation occurs that would result in the output voltage going  $\pm 10\%$  outside the setpoint value. If not used, leave unconnected.

### Recommended Pad Layout

Dimensions are in millimeters and (inches).

Tolerances: x.x mm  $\pm$  0.5 mm (x.xx in.  $\pm$  0.02 in.) [unless otherwise indicated]

x.xx mm  $\pm$  0.25 mm (x.xxx in.  $\pm$  0.010 in.)



## Technical Specification (continued)

### Nozzle Recommendations

The minimum recommended inside nozzle diameter for reliable operation is 3mm. The maximum nozzle outer diameter, which will safely fit within the allowable component spacing, is 7 mm.

### Bottom Side / First Side Assembly

This module is not recommended for assembly on the bottom side of a customer board. If such an assembly is attempted, components may fall off the module during the second reflow process

### Lead Free Soldering

The modules are lead-free (Pb-free) and RoHS compliant and fully compatible in a Pb-free soldering process. Failure to observe the instructions below may result in the failure of or cause damage to the modules and can adversely affect long-term reliability

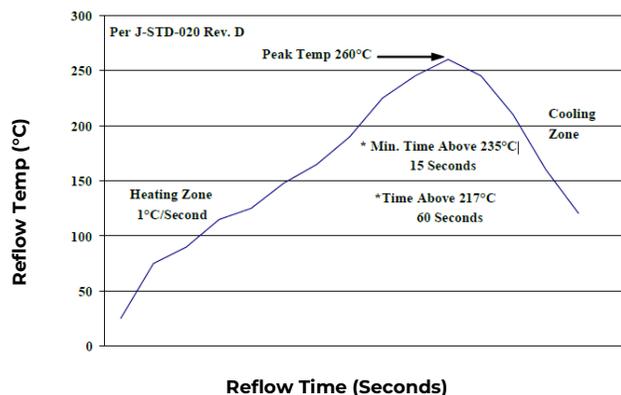
### MSL Rating

The modules have a MSL rating of 2a.

### Pb-free Reflow Profile

Power Systems will comply with J-STD-020 Rev. D (Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices) for both Pb-free solder profiles and MSL classification procedures. The suggested Pb-free solder paste is Sn/Ag/Cu (SAC).

The following profile is the recommended linear reflow profile using Sn/Ag/Cu solder. Soldering outside of the recommended profile requires testing to verify results and performance.



### Storage and Handling

J-STD-033 Rev. A (Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices) is recommended. Moisture barrier bags (MBB) with desiccant are required for MSL ratings of 2 or greater. These sealed packages should not be broken until time of use. Once the original package is broken, the floor life of the product at conditions of  $\leq 30^{\circ}\text{C}$  and 60% relative humidity varies according to the MSL rating (see J-STD-033A). The shelf life for dry packed SMT packages will be a minimum of 12 months from the bag seal date, when stored at the following conditions:  $< 40^{\circ}\text{C}$ ,  $< 90\%$  relative humidity.

### Post Solder Cleaning and Drying Considerations

Post solder cleaning is usually the final circuit-board assembly process prior to electrical board testing. The result of inadequate cleaning and drying can affect both the reliability of a power module and the testability of the finished circuit-board assembly

### Contact Us

For more information, call us at  
 1-877-546-3243 (US)  
 1-972-244-9288 (Int'l)

## Change History (excludes grammar & clarifications)

Revision	Date	Description of the change
5.3	11/11/2021	Updated as per template
5.4	05/30/2023	Correction in mechanical features on page -1
5.5	10/20/2023	Updated as per OmniOn template

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