Innovative Thinking for Power Control

OZip-R Intelligent Power Module

Hardware User's Manual

UM-0055

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1. Introduction

This document is intended to provide detailed specifications and instructions on how to properly install all configurations of the OZip-R Intelligent Power Module. In order to provide for safe installation and operation of the equipment, please read the safety guidelines at the beginning of this manual and follow the procedures outlined before connecting power to the OZip-R Intelligent Power Module.

1.1 Referenced Documents

Document	Owner	Description
114-16016	TE Connectivity	AMPSEAL Automotive Plug Connector and Header Assembly
UM-0052	Oztek	Oztek Power Studio™ User's Manual
UM-0056	Oztek	OZIP AFE/GTI Inverter User's Manual
UM-0057	Oztek	OZip Motor Drive User's Manual
UM-0060	Oztek	OZip DC/DC Converter User's Manual

1.2 General Information

Throughout this document, acronyms may be employed for brevity and readability. These are summarized in Table 1.

Table 1 – Document Acronyms

Acronym	*Full Text Equivalent*
AC	Alternating Current
AFE	Active Front End
AWG	American Wire Gauge
CAN	Controller Area Network
DC	Direct Current
ESD	Electro Static Discharge
GTI	Grid Tie Inverter
GUI	Graphical User Interface
HV	High Voltage
I/O	Input/Output
IPM	Intelligent Power Module
RH	Relative Humidity
RMS	Root Mean Square

This document applies to all models within the OZip-R Intelligent Power Module family. Consult the Model Identifier in Section 3 for orderable part numbers. Within this manual, wildcards are used, as appropriate, to signify which particular models are impacted by any particular specification. See Table 2 for definitions of the applied wildcards.

Table 2 – Wildcard Definition

Wildcard	***Meaning in Context***
*	Universal Character (All candidates apply.)
~	Exclusive Character (All except what immediately follows apply.)

1.3 Safety Notices

The following safety notices are provided for your safety and as a means of preventing damage to the product or components in the application. Specific Dangers, Warnings, and Cautions that apply to particular activities are listed at the beginning of the relevant sections and are repeated or supplemented at critical points throughout these sections. Please read the information carefully since it is provided for your personal safety and will also help prolong the service life of your OZip-R IPM and the equipment you connect to it.

1.3.1 Definitions and Symbols

 ***DANGER***	***This symbol indicates high voltage. It calls your attention to items or operations that could be dangerous to you and other persons operating this equipment. Read the message and follow the instructions carefully.***
 **WARNING**	**Indicates a potentially hazardous situation which, if not avoided, can result in serious injury or death.**
 **CAUTION**	Indicates a potentially hazardous situation which, if not avoided, can result in minor to moderate injury, or serious damage to the product. The situation described in the CAUTION may, if not avoided, lead to serious results. Important safety measures are described in CAUTION (as well as WARNING).

1.3.2 Electrical Safety

 ***DANGER***

Power inverters, such as the OZip-R IPM, are typically connected to hazardous voltages. When servicing an OZip-R IPM, there may be exposed terminals at or above line potential, as well as residual charge in place for some time after the removal of the input source. Extreme care should be taken to protect against shock.

1. ***Before startup, observe the warnings and safety instructions provided throughout this manual. All power terminals should be considered to be at utility AC or high DC potential unless verified to be otherwise. These voltages are extremely dangerous and may cause death or severe injury if contacted.***
2. ***All power terminals should be considered live with the application of input voltage regardless of operating mode of the load.***
3. ***Do not make any connections when the OZip-R IPM is connected to its power source.***
4. ***Never work on the OZip-R IPM, power cables, or load when input power is applied.***

WARNING

1. **After disconnecting the input power, residual charge will remain on the OZip-R IPM absent any external load through which that charge can dissipate. <u>It is the customer's responsibility to develop and implement a means at the application level to assure that charge is dissipated in a limited and controlled fashion for operator safety and product longevity.</u>**
2. **Do not make any insulation or voltage withstand tests on the OZip-R IPM.**
3. **Before servicing the unit, always ensure by measuring with a multimeter that**
    a. **There is no voltage between the AC terminals (A, B, & C) and the heatsink, considered chassis ground.**
    b. **There is no voltage between the DC terminals (+ & -), nor between either DC terminal and the heatsink, considered chassis ground.**

CAUTION

1. The OZip-R IPM operates on several electrical reference points, whether these be earth ground, communication ground, signal ground, etc. Proper system design with regard to equipotential bonding must be employed so that all simultaneously accessible conductive parts are electrically connected to prevent hazardous voltages appearing between them. This is accomplished by a proper factory grounding.
2. Ensure sufficient cooling for safe operation of the OZip-R IPM. Even so, power range capabilities will allow the power terminals and the heatsink of the OZip-R IPM to reach and maintain temperatures high enough to burn skin on contact. Allow adequate time for cooling before attempting to service the unit.
3. Remove any external enabling signals before resetting system faults to prevent an

unintentional restart of the OZip-R IPM, which could result in personal injury or equipment damage.

4. The OZip-R IPM is not field repairable. Never attempt to repair a malfunctioning unit; contact Oztek for a replacement.
5. Each OZip-R IPM is sealed with a warranty void sticker across the top cover which will tear if the cover is removed. A torn warranty void sticker shall be interpreted as unauthorized access to the internal contents of the OZip-R IPM, in violation of warranty terms, thereby terminating any remaining warranty otherwise in effect.

2. Shipping Information

2.1 Packaged Weights

Models	**Description**	**Weight kgf (lbs)**
OZip-R****E****	Extruded Fin Heatsink Models	20 (44)
OZip-R****F****	Fan-Cooled Extrusion Models - Module - Fan Plenum	 20 (44) 4.5 (10)
OZip-R****H****	Fan-Cooled Crossflow Models	29 (64)
OZip-R****L****	Liquid-Cooled Plate Models	17 (37)

2.2 Packaged Dimensions

Models	**Description**	**Length cm (in)**	**Width cm (in)**	**Height cm (in)**
OZip-R****E****	Extruded Fin Heatsink Models	62.5 (24.6)	43.5 (17.1)	31.8 (12.5)
OZip-R****F****	Fan-Cooled Extrusion Models - Module - Fan Plenum	 62.5 (24.6) 66.0 (26.0)	 43.5 (17.1) 38.1 (15.0)	 31.8 (12.5) 17.8 (7.0)
OZip-R****H****	Fan-Cooled Crossflow Models	69.3 (27.3)	46.5 (18.3)	38.1 (15.0)
OZip-R****L****	Liquid-Cooled Plate Models	62.5 (24.6)	43.5 (17.1)	31.8 (12.5)

2.3 Unpacking and Inspection

CAUTION

1. Using the provided packing list, verify that the model received corresponds to that ordered. Note that inverter controller models OZip-R*****I*** will also require an Oztek High Voltage Sense module, packaged independently.
2. Inspect packaging for any signs of shipping damage. Immediately seek assistance from the freight carrier for any visible signs that the packaging or product has been compromised.
3. The OZip-R IPM is a sensitive electronic device. While it has been designed to mitigate risks of ESD damage under normal circumstances, care should be taken not to handle electrical interfaces unnecessarily.
4. Using the product weight information as provided in Sections 2.1 and 4.1, determine whether the model received requires team lift handling according to recipient's policies for lifting restrictions. Handle accordingly.
5. Lift only by the handles. Rest air-cooled models (OZip-R****~L****) only on their fins and liquid cooled models (OZip-R****L****) only on the cold plate base.

WARNING

1. **Through visual inspection of the labeled product itself, confirm that the received model corresponds to that shown on the packing list.**
2. **Verify that the product itself has not been damaged in shipping or handling.**
3. **Do not install or operate an OZip-R IPM which is either the incorrect model for the intended application or shows evidence of damage as a result of shipping or handling. Doing so risks serious injury to the operator and severe damage to the OZip-R IPM and related equipment.**

3. OZip-R Model Identifier

Use Figure 1 to identify the model of OZip-R Intelligent Power Module in question. As shown, the model would be OZip-R1260LMM, a liquid cooled, motor drive built with 1200V, 600A IGBTs and controlled via RS-485 Modbus protocol, without any factory customization.

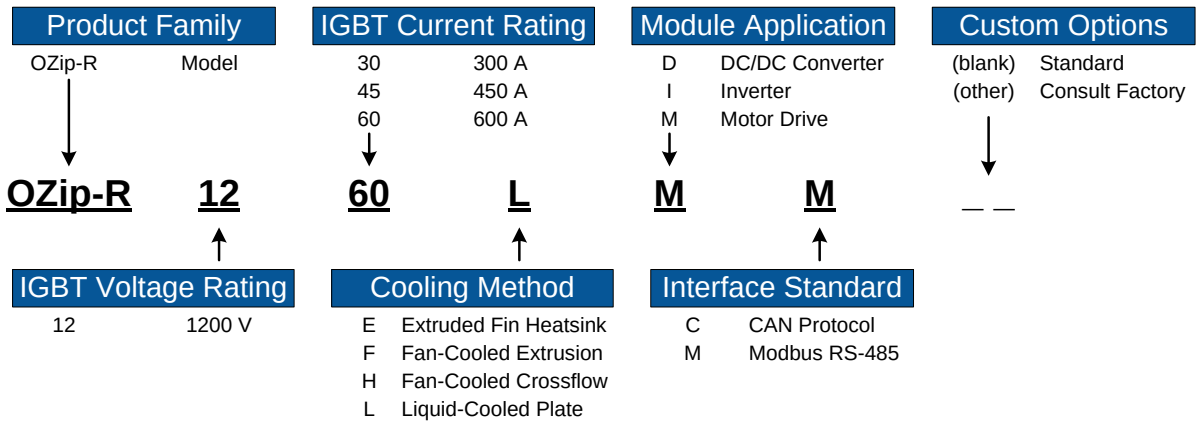


Figure 1: OZip-R Part Number Identifier

4. Physical Characteristics

4.1 Product Weights

Models	Description	Weight kgf (lbs)
OZip-R****E****	Extruded Fin Heatsink Models	17 (37)
OZip-R****F****	Fan-Cooled Extrusion Models	20 (44)
OZip-R****H****	Fan-Cooled Crossflow Models	26 (57)
OZip-R****L****	Liquid-Cooled Plate Models	14 (30)

4.2 Product Dimensions

The product dimensions are associated with the selected “Cooling Method”, as defined by the Part Number Identifier of Figure 1. The following sections provide illustrations for each cooling configuration. Consult the Oztek website (www.oztekcorp.com) for the latest para-solid models of each configuration.

Note that in the case of the Fan-Cooled Extrusion Models (Section 4.2.2), the illustrations show the Lengthwise Fan Plenum Assembly attached at the edge opposite the interface connector. This mounting is arbitrarily selected for illustrative purposes. The plenum is symmetrical, and the customer may just as easily mount from the other side, nearer the interface connector, with no adverse impact on performance.

4.2.1 Extruded Fin Heatsink Models (OZip-R****E****)

Figure 2: OZip-R****E**** Illustration in Perspective

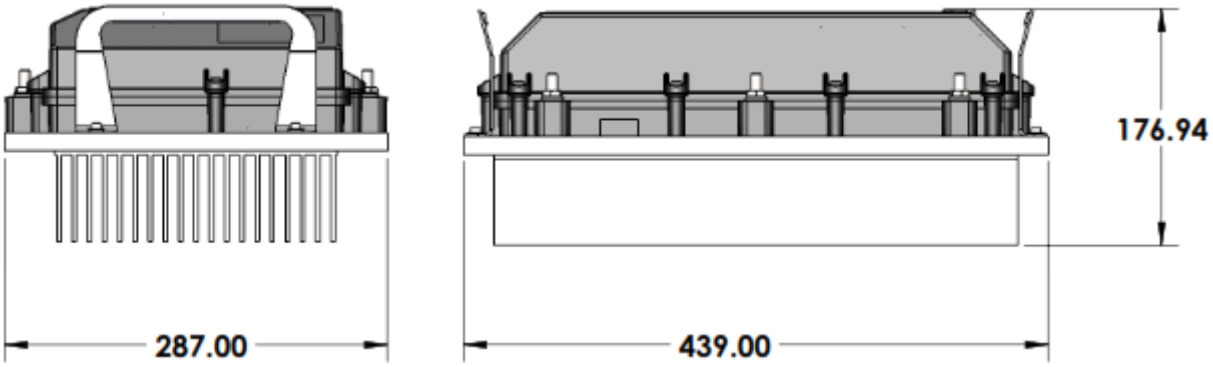


Figure 3: OZip-R****E**** Mechanical Outline

4.2.2 Fan-Cooled Extrusion Models (OZip-R****F ****)

Figure 4: OZip-R****F**** Illustration in Perspective

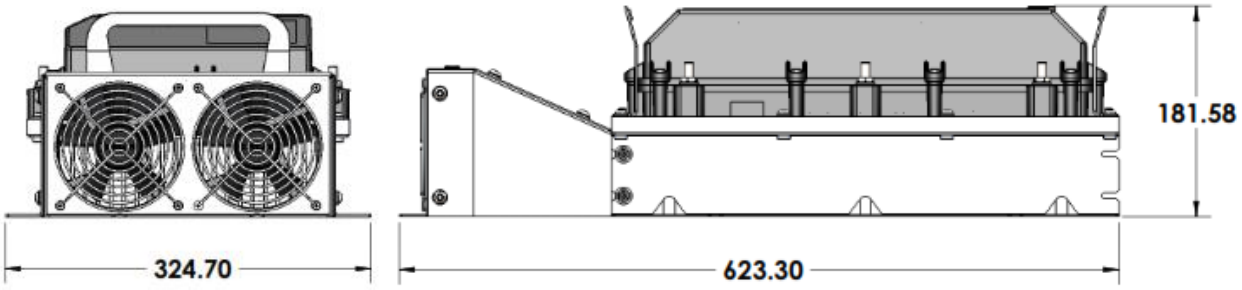


Figure 5: OZip-R****F**** Mechanical Outline

Mounting the Lengthwise Fan Plenum Assembly is the customer's responsibility. For illustrative purposes, it is shown attached to the side opposite the interface connector in both Figure 4 and Figure 5. The customer may wish to attach this plenum from the other side, nearer the interface connector. This is perfectly acceptable, as there is no impact on performance in either configuration.

4.2.3 Fan-Cooled Crossflow Models (OZip-R****H ****)

Figure 6: OZip-R****H**** Illustration in Perspective

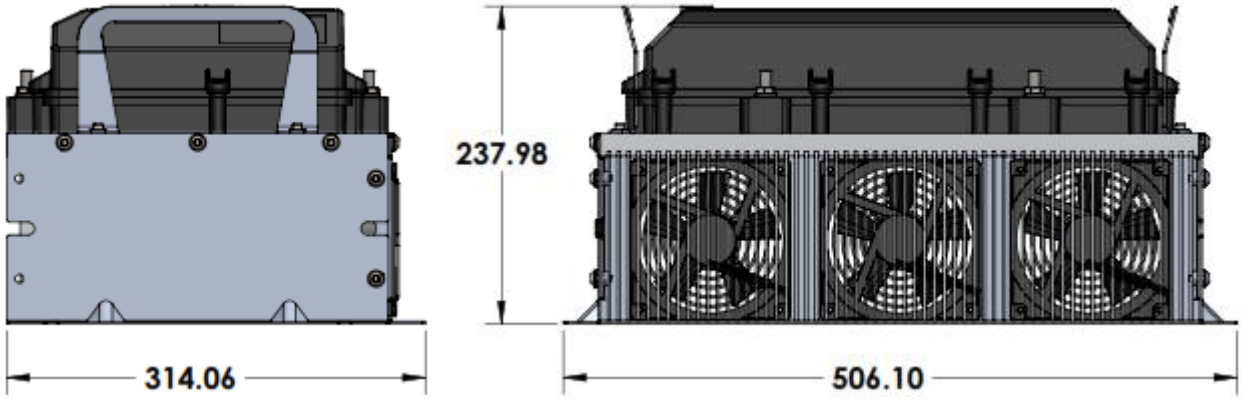


Figure 7: OZip-R****H**** Mechanical Outline

4.2.4 Liquid-Cooled Plate Models (OZip-R****L ****)

Figure 8: OZip-R****L**** Illustration in Perspective

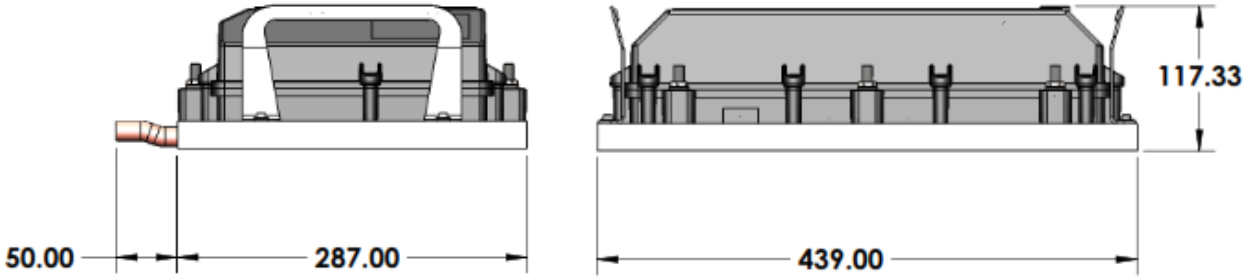


Figure 9: OZip-R****L**** Mechanical Outline

5. Electrical Characteristics

5.1 Power Circuitry

5.1.1 Absolute Maximum Ratings

- DC Link Voltage: **1000** V_{DC} (1)
- Phase Current:
  - Models OZip-R**30*****: **424** A_{PK}
  - Models OZip-R**45*****: **495** A_{PK}
  - Models OZip-R**60*****: **566** A_{PK}

(1) Protection disables switching at 900 V_{DC}.

5.1.2 Recommended Maximum Operating Conditions

- DC Link Voltage: **850** V_{DC}
- Continuous Phase Current(2):
  - Models OZip-R**30F****: **125** A_{RMS} at 3 kHz, 45°C ambient temperature

  - Models OZip-R**30E****: **125** A_{RMS} at 3 kHz, 5.7 m^3/minute 45°C airflow
    165 A_{RMS} at 3 kHz, 11.3 m^3/minute 45°C airflow
  - Models OZip-R**30H****: **205** A_{RMS} at 3 kHz, 45°C ambient temperature
  - Models OZip-R****L****: **250** A_{RMS} at 3 kHz, 45°C ambient temperature
- Transient Load Current[(2)(3)]:
  - Models OZip-R****F****: **248** A
  - Models OZip-R****E****: **188** A at 5.7 m^3/minute 45°C airflow
    248 A at 11.3 m^3/minute 45°C airflow
  - Models OZip-R****H****: **267** A
  - Models OZip-R**30L****: **300** A
  - Models OZip-R**~30L****: **375** A
- Switching Frequency:
  - Models OZip-R**30*****: **12** kHz
  - Models OZip-R**45*****: **9** kHz
  - Models OZip-R**60*****: **6** kHz

(2) Assumes like voltage of 750 V_{DC} and 50/60 Hz inverter operation or DC/DC converter with 50% duty cycle.

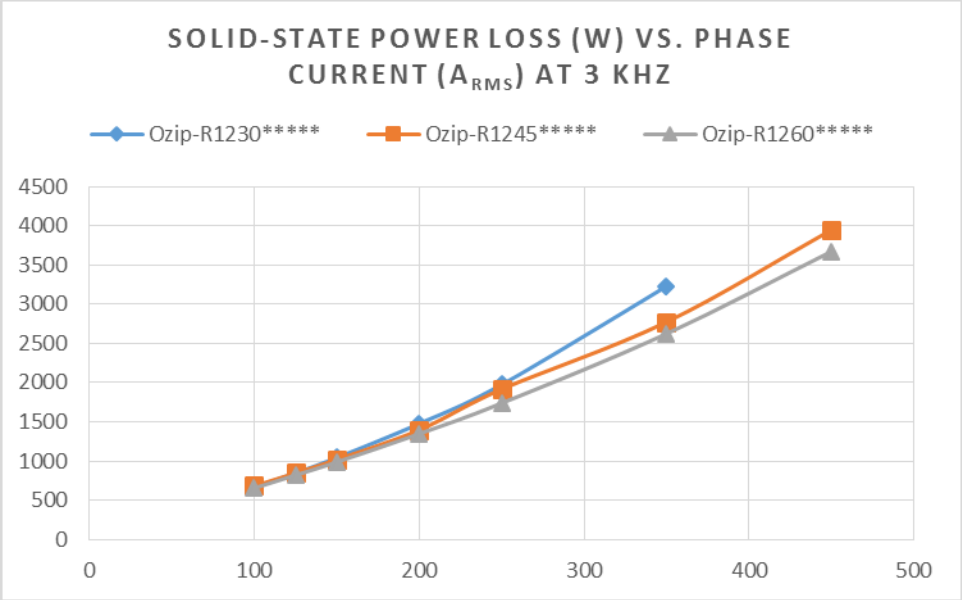
(3) Duration of less than 10 seconds.

5.1.3 Power Loss Curves

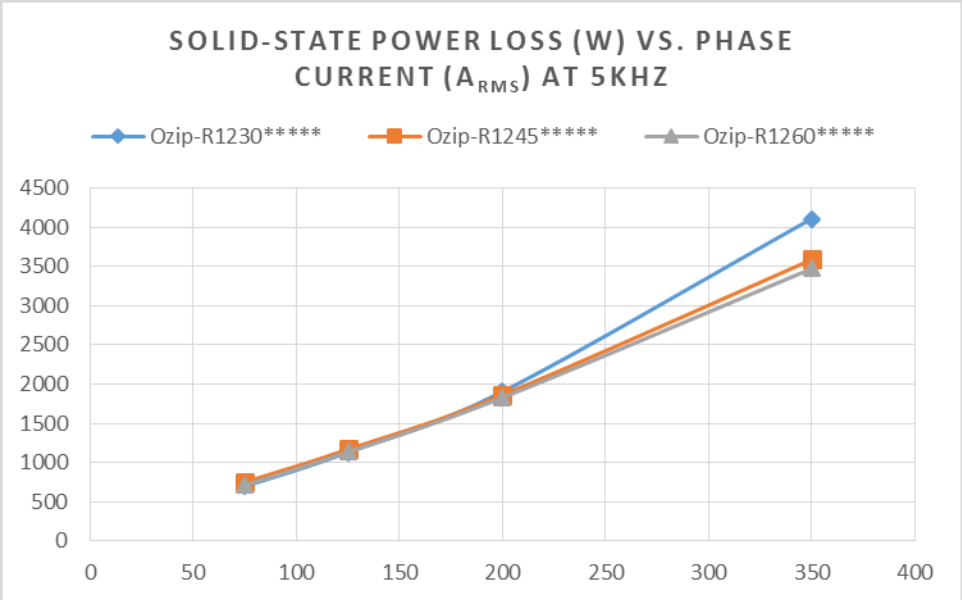
The following curves provide representative solid state power losses for the various OZip-R IPM models grouped by "IGBT Current Rating", as defined by the Part Number Identifier of Figure 1, as a function of phase current. These curves are provided at numerous switching frequencies, but always under similar operating conditions, including the following:

- Heatsink Temperature: 85°C.
- DC Link Voltage: 750 V.
- Gate drive "on" resistance: 2.0 Ω.
- Gate drive "off" resistance: 1.5 Ω.

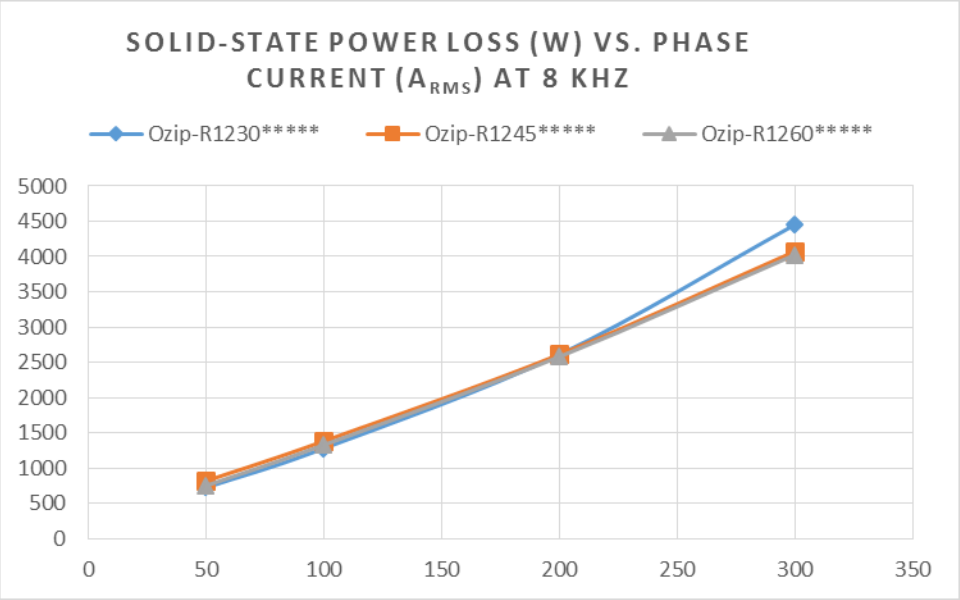
		Ozip-R1230*****			Ozip-R1245*****			Ozip-R1260*****		
Switching Frequency [kHz]	Phase Current [A]	IGBT loss [W]	Diode loss [W]	Total loss [W]	IGBT loss [W]	Diode loss [W]	Total loss [W]	IGBT loss [W]	Diode loss [W]	Total loss [W]
3	100	78.6	32.9	669	75.47	38.18	682	80.57	28.64	655
3	125	102	39.27	848	95.97	45.1	846	102	34.63	820
3	150	128	45.74	1042	118	51.93	1020	124	40.63	988
3	200	187	59.05	1476	167	65.54	1395	172	52.59	1348
3	250	256	73	1974	222	97.32	1916	225	64.6	1738
3	350	435	103	3228	354	108	2772	348	89.15	2623
3	450				520	138	3948	497	115	3672



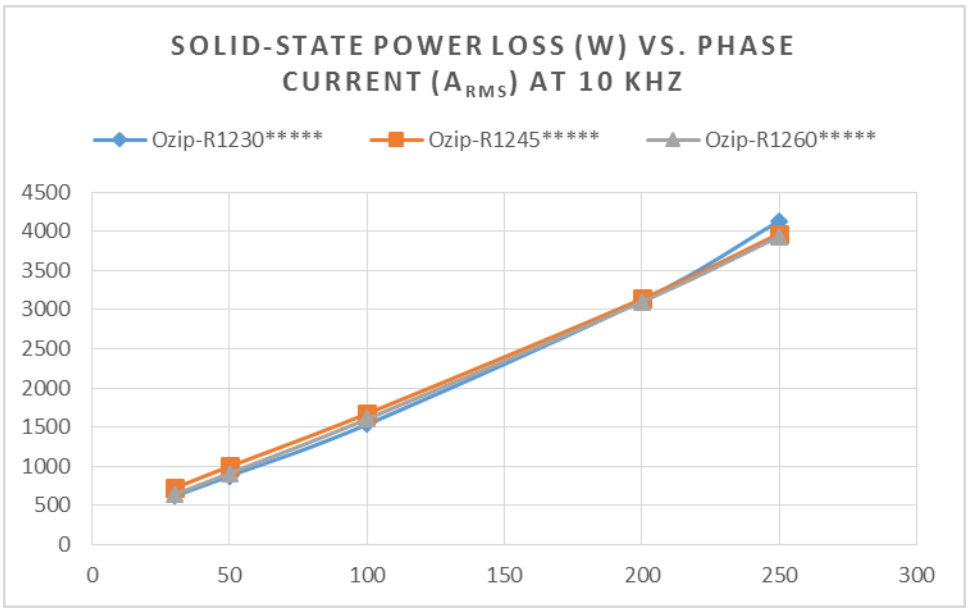
		Ozip-R1230*****			Ozip-R1245*****			Ozip-R1260*****		
Switching Frequency [kHz]	Phase Current [A]	IGBT loss [W]	Diode loss [W]	Total loss [W]	IGBT loss [W]	Diode loss [W]	Total loss [W]	IGBT loss [W]	Diode loss [W]	Total loss [W]
5	75	76.31	39.56	695	77.2	47.9	750	85.31	33.33	712
5	125	132	56.53	1131	127	67.7	1168	139	50.15	1135
5	200	236	81.63	1906	215	95.38	1862	231	73.94	1830
5	350	550	135	4110	448	150	3588	459	120	3474



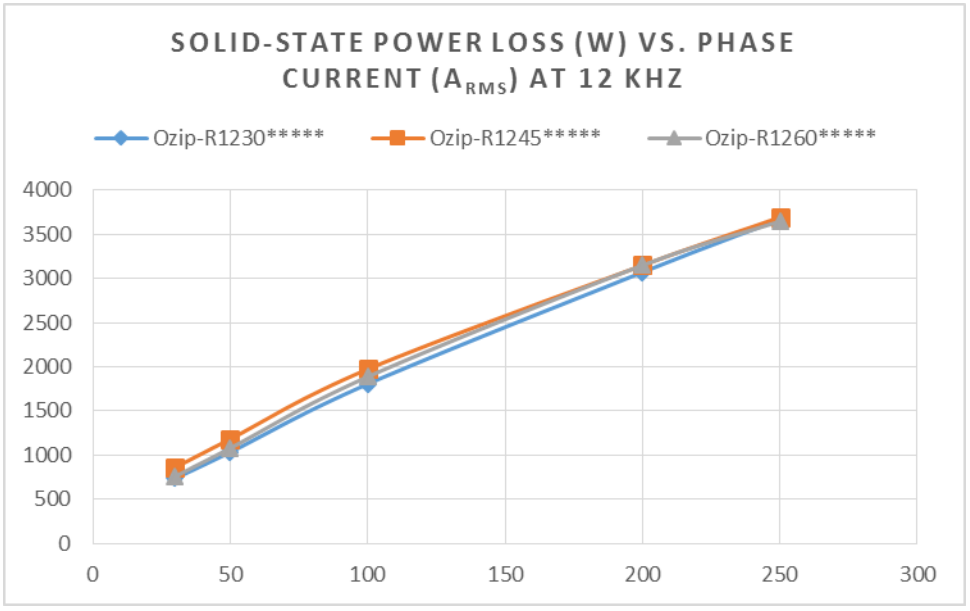
		Ozip-R1230*****			Ozip-R1245*****			Ozip-R1260*****		
Switching Frequency [kHz]	Phase Current [A]	IGBT loss [W]	Diode loss [W]	Total loss [W]	IGBT loss [W]	Diode loss [W]	Total loss [W]	IGBT loss [W]	Diode loss [W]	Total loss [W]
8	50	73.53	46.74	722	78.5	57.5	816	88.08	36.78	749
8	100	141	72.16	1279	141	89.26	1382	159	62.4	1328
8	200	317	118	2610	292	143	2610	323	107	2580
8	300	578	164	4452	486	193	4074	523	148	4026



		Ozip-R1230*****			Ozip-R1245*****			Ozip-R1260*****		
Switching Frequency [kHz]	Phase Current [A]	IGBT loss [W]	Diode loss [W]	Total loss [W]	IGBT loss [W]	Diode loss [W]	Total loss [W]	IGBT loss [W]	Diode loss [W]	Total loss [W]
10	30	60.46	42.91	620	68.2	52.3	722	75.8	30.92	640
10	50	88.35	57.86	877	95.0	71.5	999	107	45.21	913
10	100	167	88.9	1535	168	111	1674	191	76.43	1605
10	200	376	144	3120	346	177	3138	387	130	3102
10	250	518	171	4134	454	208	3972	501	155	3936

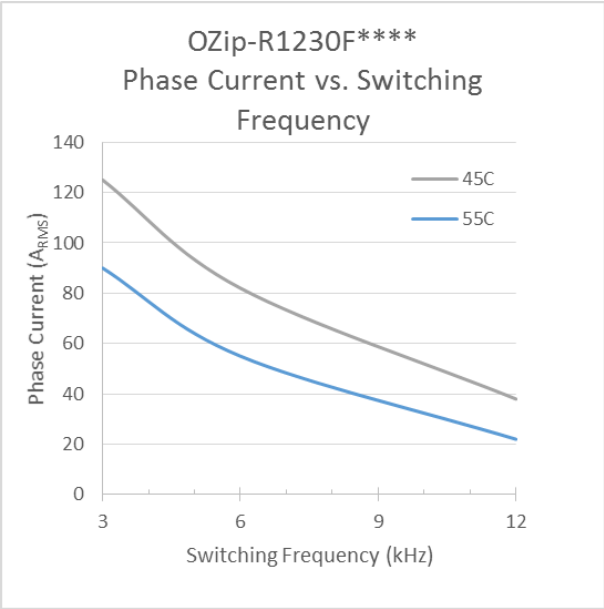


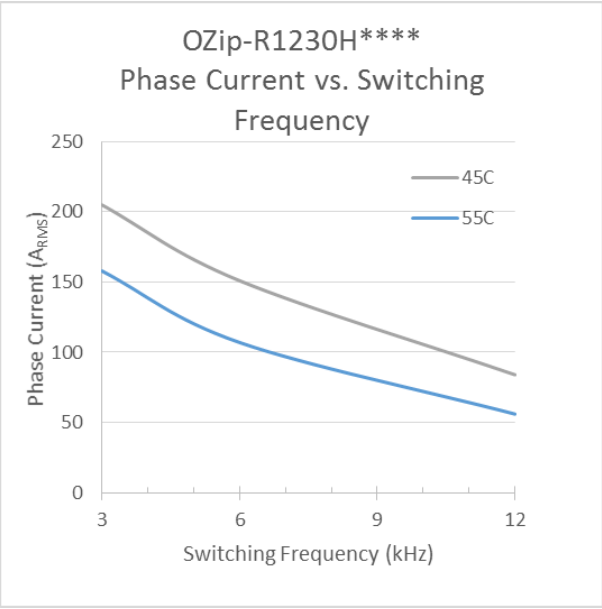
Switching Frequency [kHz]	Phase Current [A]	IGBT loss [W]	Diode loss [W]	Total loss [W]	IGBT loss [W]	Diode loss [W]	Total loss [W]	IGBT loss [W]	Diode loss [W]	Total loss [W]
12	30	71.3	51.43	736	80.7	62.8	861	89.72	36.8	759
12	50	103	69.25	1034	111.0	86.0	1182	126	53.72	1078
12	100	195	106	1806	196	133	1974	224	90.55	1887
12	200	367	145	3072	347	178	3150	397	128	3150
12	250	441	171	3672	403	213	3696	454	154	3648

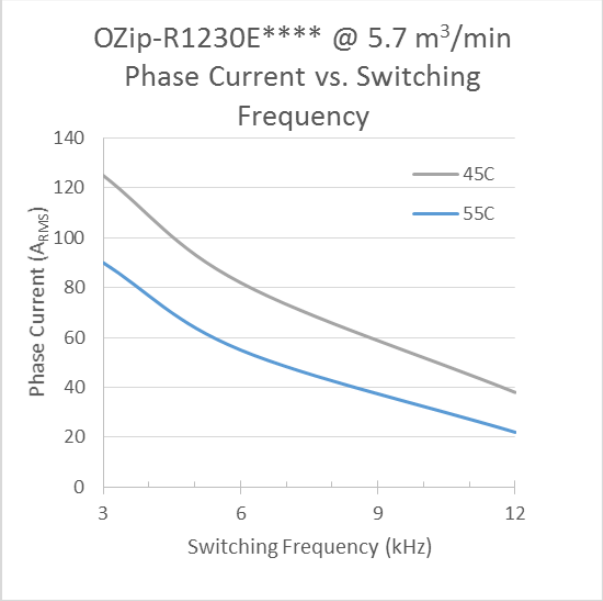


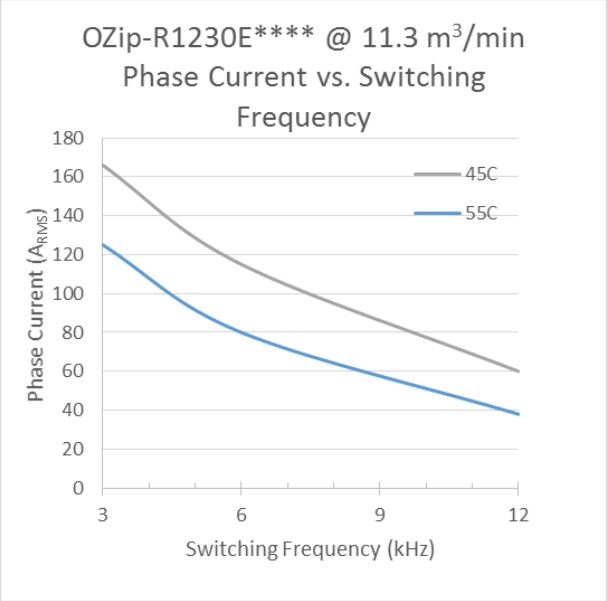
5.1.4 Phase Current Derating

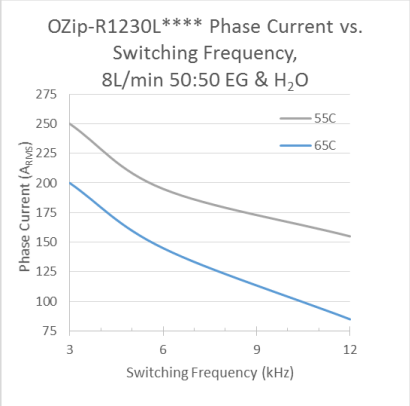
The following curves provide representative phase current derating versus switching frequency for various ambient temperatures. These curves are provided according to OZip-R IPM "Cooling Method"", as defined by the Part Number Identifier of Figure 1, with flow rates either as default levels per the integrated fan assemblies (OZip-R****F**** and OZip-R****H****), or as specified in the charts.

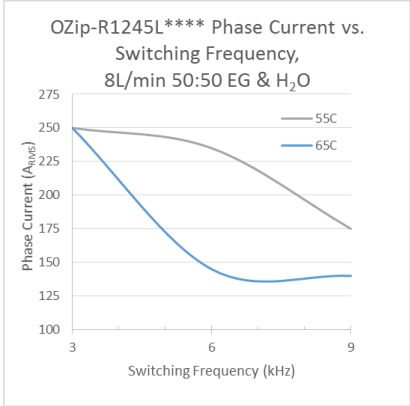


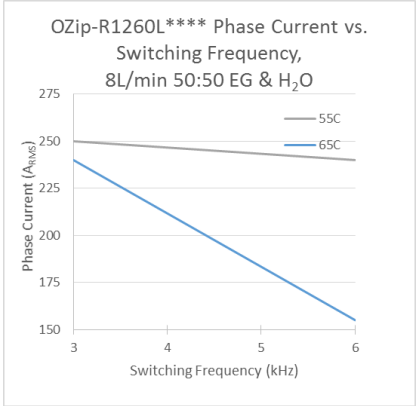












5.2 Control Signal Circuitry

5.2.1 Control Signal Connector Definition

The signal interface to the OZip-R Intelligent Power Module is as shown schematically in Figure 10 and physically in Figure 11. It is part number 1-776231-1 from TE Connectivity, or its equivalent.

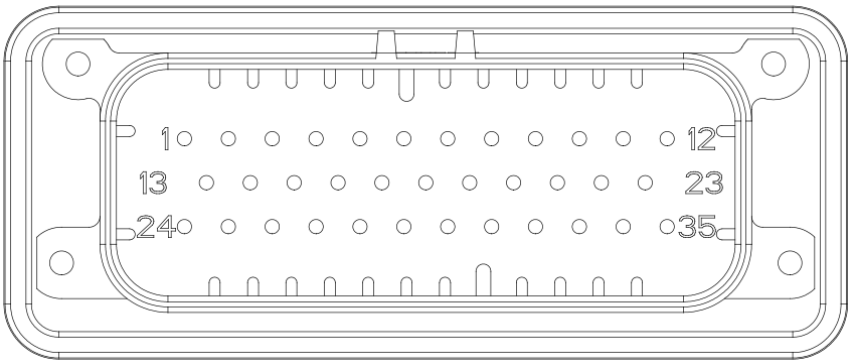


Figure 10: Signal Interface Header Illustration

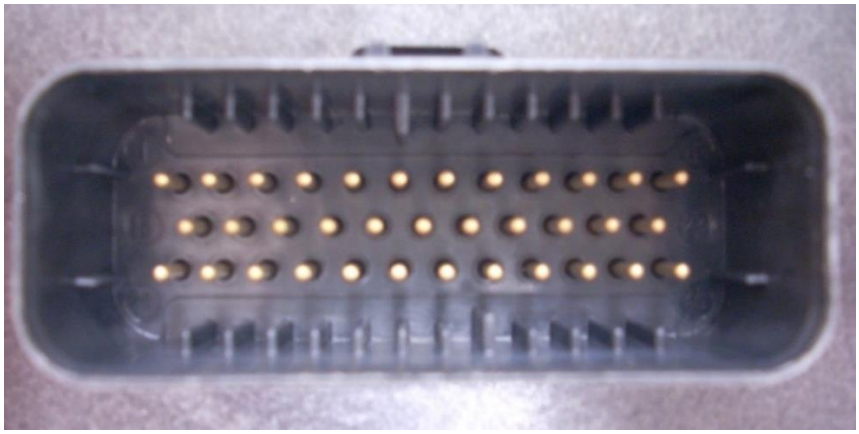


Figure 11: Signal Interface Header Image

5.2.2 Contact Assignment and Electrical Specifications

The contact assignments are dependent upon "Module Application", as defined by the Part Number Identifier of Figure 1. Consult Table 3 for contact assignments when the OZip-R Intelligent Power Module is intended for motor drive applications [OZip-R*****M***]; consult Table 4 for all other applications [OZip-R*****~M***]. Details of signals and their functions related to Table 3 can be found in UM-0057 OZip Motor Drive User's Manual, while details related to Table 4 can be found in either UM-0056 OZip AFE/GTI Inverter User's Manual or UM-0060 OZip DC/DC Converter User's Manual, as appropriate.

Additionally, note that within each table, several pins (14 & 26 as "COM+" and 15 & 27 as "COM-") vary in functionality depending upon whether the "Interface Standard", as again defined by the Part Number Identifier of Figure 1, indicates that the unit is configured for CAN protocol [OZip-R******C**] or for Modbus RS-485 serial communication [OZip-R******M**].

Table 3 – Contact Assignment and Interface Specifications for Motor Drives (OZip-R*****M***)

Pin	*Signal*	*Function*	*Electrical Specifications*
1	BIAS+	Input bias voltage used to power control & interface electronics	Maximum voltage: 40V_{DC} (relative to BIAS-). Operating Voltage Range: 18 to 32V_{DC}. (See section 8.4 for additional restrictions.)
2	SW4	Low side inductive load driver	Maximum voltage: 60V_{DC} (relative to BIAS-). Nominal load current < 1.3 A at 25°C. Recommended load voltage < 36V_{DC}.
3	SW3	Low side inductive load driver	Maximum voltage: 60V_{DC} (relative to BIAS-). Nominal load current < 1.3 A at 25°C. Recommended load voltage < 36V_{DC}.
4	SW2	Low side inductive load driver	Maximum voltage: 60V_{DC} (relative to BIAS-). Nominal load current < 1.3 A at 25°C. Recommended load voltage < 36V_{DC}.
5	SW1	Low side inductive load driver	Maximum voltage: 60V_{DC} (relative to BIAS-). Nominal load current < 1.3 A at 25°C. Recommended load voltage < 36V_{DC}.
6	DIN3	Logic level digital input	Maximum voltage: 5V_{DC} (relative to DGND). Minimum voltage: -0.5V_{DC} (relative to DGND). Input low: < 0.5V_{DC}; input high: > 2.4V_{DC}.
7	AGND	Analog ground	0V analog reference level.
8	TEMP	Thermistor temperature sensor	Maximum voltage: 5.3V_{DC} (relative to AGND). Minimum voltage: -0.5V_{DC} (relative to AGND). Typical thermistor value ranging from 1kΩ to 10kΩ.
9	5V_A	Analog 5V supply output	Typical short circuit load current (w/ "5V_D"): 350 mA. Typical peak output current (w/ "5V_D"): 700 mA. Output voltage range: 4.8 to 5.2V_{DC} (relative to AGND).
10	ADC1	Analog input	Maximum voltage: 5.3V_{DC} (relative to AGND). Minimum voltage: -0.5V_{DC} (relative to AGND). Recommended operating voltage range: 0.0 to 5.0V_{DC} (relative to AGND).

Pin	*Signal*	*Function*	*Electrical Specifications*
11	ADC2	Analog input	Maximum voltage: 5.3V_{DC} (relative to AGND). Minimum voltage: -0.5V_{DC} (relative to AGND). Recommended operating voltage range: 0.0 to 5.0V_{DC} (relative to AGND).
12	AGND	Analog ground	0V analog reference level.
13	BIAS-	Input bias voltage return	0V bias input reference level.
14	COM+	Communications port positive differential input	CAN Models OZip-R******C** - Maximum voltage range: -36 to 36V (relative to COM-). - Recommended operating voltage: -7 to 12V (relative to COM_GND). - Recommended operating differential voltage: -6 to 6V (relative to COM-). RS-485 Modbus Models OZip-R******M** - Maximum voltage range: -13 to 16.5V (relative to COM-). - Recommended operating voltage: -7 to 12V (relative to COM_GND). - Recommended operating differential voltage: -12 to 12V (relative to COM-).
15	COM-	Communications port negative differential input	CAN Models OZip-R******C** - Maximum voltage range: -36 to 36V (relative to COM+). - Recommended operating voltage: -7 to 12V (relative to COM_GND). - Recommended operating differential voltage: -6 to 6V (relative to COM+). RS-485 Modbus Models OZip-R******M** - Maximum voltage range: -13 to 16.5V (relative to COM+). - Recommended operating voltage: -7 to 12V (relative to COM_GND). - Recommended operating differential voltage: -12 to 12V (relative to COM+).
16	DIN1	Logic level digital input	Maximum voltage: 5V_{DC} (relative to DGND). Minimum voltage: -0.5V_{DC} (relative to DGND). Input low: < 0.5V_{DC}; input high: > 2.4V_{DC}.
17	DIN2	Logic level digital input	Maximum voltage: 5V_{DC} (relative to DGND). Minimum voltage: -0.5V_{DC} (relative to DGND). Input low: < 0.5V_{DC}; input high: > 2.4V_{DC}.
18	DIN4	Logic level digital input	Maximum voltage: 5V_{DC} (relative to DGND). Minimum voltage: -0.5V_{DC} (relative to DGND). Input low: < 0.5V_{DC}; input high: > 2.4V_{DC}.
19	DGND	Digital ground	0V digital reference level.
20	ENCA+	Encoder A channel positive differential input	Maximum voltage range: -7 to 7V (relative to ENCA-). Recommended operating voltage: 0 to 3V (relative to DGND). Recommended operating differential voltage: -3 to 3V (relative to ENCA-).

Pin	*Signal*	*Function*	*Electrical Specifications*
21	ENCA-	Encoder A channel negative differential input	Maximum voltage range: -7 to 7V (relative to ENCA+). Recommended operating voltage: 0 to 3V (relative to DGND). Recommended operating differential voltage: -3 to 3V (relative to ENCA+).
22	ENCB+	Encoder B channel positive differential input	Maximum voltage range: -7 to 7V (relative to ENCB-). Recommended operating voltage: 0 to 3V (relative to DGND). Recommended operating differential voltage: -3 to 3V (relative to ENCB-).
23	ENCB-	Encoder B channel negative differential input	Maximum voltage range: -7 to 7V (relative to ENCB+). Recommended operating voltage: 0 to 3V (relative to DGND). Recommended operating differential voltage: -3 to 3V (relative to ENCB+).
24	BIAS-	Input bias voltage return	0V bias input reference level.
25	COM_GND	Isolated communications port ground	0V communication circuit reference level.
26	COM+	Communications port positive differential input	CAN Models OZip-R******C** - Maximum voltage range: -36 to 36V (relative to COM-). - Recommended operating voltage: -7 to 12V (relative to COM_GND). - Recommended operating differential voltage: -6 to 6V (relative to COM-). RS-485 Modbus Models OZip-R******M** - Maximum voltage range: -13 to 16.5V (relative to COM-). - Recommended operating voltage: -7 to 12V (relative to COM_GND). - Recommended operating differential voltage: -12 to 12V (relative to COM-).
27	COM-	Communications port negative differential input	CAN Models OZip-R******C** - Maximum voltage range: -36 to 36V (relative to COM+). - Recommended operating voltage: -7 to 12V (relative to COM_GND). - Recommended operating differential voltage: -6 to 6V (relative to COM+). RS-485 Modbus Models OZip-R******M** - Maximum voltage range: -13 to 16.5V (relative to COM+). - Recommended operating voltage: -7 to 12V (relative to COM_GND). - Recommended operating differential voltage: -12 to 12V (relative to COM+).
28	DGND	Digital ground	0V digital reference level.
29	5V_D	Digital 5V supply output	Typical short circuit load current (w/ “5V_A”): 350 mA. Typical peak output current (w/ “5V_A”): 700 mA. Output voltage range: 4.8 to 5.2V_{DC} (relative to DGND).

Pin	Signal	Function	Electrical Specifications
30	AOUT1	Analog output	Output voltage range: 0 to $5V_{DC}$ (relative to DGND). Typical short circuit current (with AOUT2): +/- 50 mA.
31	AOUT2	Analog output	Output voltage range: 0 to $5V_{DC}$ (relative to DGND). Typical short circuit current (with AOUT1): +/- 50 mA.
32	DIN5	Logic level digital input	Maximum voltage: $5V_{DC}$ (relative to DGND). Minimum voltage: $-0.5V_{DC}$ (relative to DGND). Input low: < $0.5V_{DC}$; input high: > $2.4V_{DC}$.
33	FAN_PWM	Fan control output	Output voltage range: 0 to 5V (relative to BIAS-). Source current capability: < 2.5mA.
34	DGND	Digital ground	0V digital reference level.
35	SHIELD	Chassis ground connection for shield	Maximum voltage offset from heatsink (chassis): 45V.

Table 4 – Contact Assignment and Interface Specifications for Non-Motor Drive Applications (OZip-R*****~M***)

Pin	Signal	Function	Electrical Specifications
1	BIAS+	Input bias voltage used to power control & interface electronics	Maximum voltage: $40V_{DC}$ (relative to BIAS-). Operating Voltage Range: 18 to $32V_{DC}$. (See section 8.4 for additional restrictions.)
2	BIAS-	Input bias voltage return	0V bias input reference level.
3	BIAS-	Input bias voltage return	0V bias input reference level.
4	FAN_PWM	Fan control output	Output voltage range: 0 to 5V (relative to BIAS-). Source current capability: < 2.5mA.
5	FLT_OUT	Isolated fault output signal, open collector	Maximum open collector voltage: $45V_{DC}$ (relative to FLT_OUT_RTN). Maixum load current < 50 mA at 25°C. Recommended nominal load current = 2 mA.
6	FLT_OUT_RTN	Fault output return	0V reference level for open collector fault output signal.
7	TEMP_RTN	Thermistor temperature sensor return	0V analog reference level for temperature measurement.
8	TEMP	Thermistor temperature sensor	Maximum voltage: $3.6V_{DC}$ (relative to AGND). Minimum voltage: $-0.5V_{DC}$ (relative to AGND). Typical thermistor value ranging from 1kΩ to 10kΩ.
9	HV_5V	Extrenal 5V supply output for use with high voltage sense	Typical short circuit load current: 350 mA. Typical peak output current: 700 mA. Output voltage range: 4.8 to $5.2V_{DC}$ (relative to HV_GND).
10	HV_GND	Digital ground	0V digital reference level.
11	HV_DIN+	High voltage sense positive differential input signal	Maximum voltage range: -5 to 5V (relative to HV_DIN-). Recommended operating voltage: 0 to 3V (relative to HV_GND). Recommended operating differential voltage: -3 to 3V (relative to HV_DIN-).
12	RLY3_DRV	Relay3 Driver – low side inductive load driver output	Maximum voltage: $60V_{DC}$ (relative to BIAS-). Nominal load current < 1.3 A at 25°C. Recommended load voltage < $36V_{DC}$.
13	COM_SHIELD	Chassis ground connection for shielding communication signals	Maximum voltage offset from heatsink (chassis): 45V.

Pin	*Signal*	*Function*	*Electrical Specifications*
14	COM+	Communications port positive differential signal	CAN Models OZip-R******C** - Maximum voltage range: -36 to 36V (relative to COM-). - Recommended operating voltage: -7 to 12V (relative to COM_GND). - Recommended operating differential voltage: -6 to 6V (relative to COM-). RS-485 Modbus Models OZip-R******M** - Maximum voltage range: -13 to 16.5V (relative to COM-). - Recommended operating voltage: -7 to 12V (relative to COM_GND). Recommended operating differential voltage: -12 to 12V (relative to COM-).
15	COM-	Communications port negative differential signal	CAN Models OZip-R******C** - Maximum voltage range: -36 to 36V (relative to COM+). - Recommended operating voltage: -7 to 12V (relative to COM_GND). - Recommended operating differential voltage: -6 to 6V (relative to COM+). RS-485 Modbus Models OZip-R******M** - Maximum voltage range: -13 to 16.5V (relative to COM+). - Recommended operating voltage: -7 to 12V (relative to COM_GND). Recommended operating differential voltage: -12 to 12V (relative to COM+).
16	FLT_RST	Isolated fault reset input signal	Operating Voltage Range: 0 to 40V_{DC} (relative to FLT_RST_RTN). Minimum signal input high level: 5.0V_{DC}. Maximum signal input low level: 0.8V_{DC}.
17	ILOCK	Isolated interlock input signal	Operating Voltage Range: 0 to 40V_{DC} (relative to ILOCK_RTN). Minimum signal input high level: 5.0V_{DC}. Maximum signal input low level: 0.8V_{DC}.
18	ON/OFF	Isolated on/off input signal	Operating Voltage Range: 0 to 40V_{DC} (relative to ON/OFF_RTN). Minimum signal input high level: 5.0V_{DC}. Maximum signal input low level: 0.8V_{DC}.
19	RLY1_STAT	Relay1 status input signal	Operating Voltage Range: 0 to 40V_{DC} (relative to BIAS-). Minimum signal input high level: 5.0V_{DC}. Maximum signal input low level: 0.8V_{DC}.
20	HV_CLK+	High voltage sense clock positive differential output signal	Maximum voltage range: -5 to 5V (relative to HV_CLK-). Recommended operating voltage: 0 to 3V (relative to HV_GND). Recommended operating differential voltage: -3 to 3V (relative to HV_CLK-).

Pin	Signal	Function	Electrical Specifications
21	HV_DOUT-	High voltage sense negative differential output signal	Maximum voltage range: -5 to 5V (relative to HV_DOUT+). Recommended operating voltage: 0 to 3V (relative to HV_GND). Recommended operating differential voltage: -3 to 3V (relative to HV_DOUT+).
22	HV_DIN-	High voltage sense negative differential input signal	Maximum voltage range: -5 to 5V (relative to HV_DIN+). Recommended operating voltage: 0 to 3V (relative to HV_GND). Recommended operating differential voltage: -3 to 3V (relative to HV_DIN+).
23	RLY2_DRV	Relay2 Driver – low side inductive load driver output	Maximum voltage: 60V_{DC} (relative to BIAS-). Nominal load current < 1.3 A at 25°C. Recommended load voltage < 36V_{DC}.
24	COM_GND	Isolated communications port ground	0V communication circuit reference level.
25	COM+	Communications port positive differential signal	See pin 14 specifications
26	COM-	Communications port negative differential signal	See pin 15 specifications
27	COM_GND	Isolated communications port ground	0V communication circuit reference level.
28	FLT_RST_RTN	Fault reset return	0V reference level for fault reset input signal.
29	ILOCK_RTN	Interlock return	0V reference level for interlock input signal.
30	ON/OFF_RTN	On/Off return	0V reference level for on/off input signal.
31	RLY2_STAT	Relay2 status input signal	Operating Voltage Range: 0 to 40V_{DC} (relative to BIAS-). Minimum signal input high level: 5.0V_{DC}. Maximum signal input low level: 0.8V_{DC}.
32	HV_CLK-	High voltage sense clock negative differential output signal	Maximum voltage range: -5 to 5V (relative to HV_CLK+). Recommended operating voltage: 0 to 3V (relative to HV_GND). Recommended operating differential voltage: -3 to 3V (relative to HV_CLK+).
33	HV_DOUT+	High voltage sense positive differential output signal	Maximum voltage range: -5 to 5V (relative to HV_DOUT-). Recommended operating voltage: 0 to 3V (relative to HV_GND). Recommended operating differential voltage: -3 to 3V (relative to HV_DOUT-).
34	HV_SHIELD	Chassis ground connection for shielding high voltage signals	Maximum voltage offset from heatsink (chassis): 45V.
35	RLY1_DRV	Relay1 Driver – low side inductive load driver output	Maximum voltage: 60V_{DC} (relative to BIAS-). Nominal load current < 1.3 A at 25°C. Recommended load voltage < 36V_{DC}.

5.3 Circuit Isolation

Circuit isolation shall be defined in reference to the following islands of electrical potential:

- Chassis – the heatsink or cold plate, presumed to be tied to Earth (Safety) ground per Section 7.1.
- Power terminals – AC phase terminals and DC rail terminals, as specified in Section 7.2.
- Bias potential – references for module control (AGND, DGND, BIAS-, TEMP_RTN, HV_GND), as specified in Section 5.2.2.
- Communication reference – COM_GND for CAN/Modbus communication, as specified in Section 5.2.2.
- Differential I/O – Various application specific signals, as specified in Section 5.2.2.
- Shields – Communication or HV sense cable braid or foil, as specified in Section 5.2.2.

Isolation boundaries shall conform to the specifications of Table 5.

Table 5 – Isolation Boundary Comparison

Units = V	***Chassis (Earth)***	***Power Terminals***	***Bias Potential***	***Communication Reference***	***Differential I/O***	***Shields***
Chassis (Earth)		2500	45	550	600	45
Power Terminals	2500		2500	3000	3000	3000
Bias Potential	45	2500		500	550	90
Communication Reference	550	3000	500		1000	600
Differential I/O	600	3000	550	1000		600
Shields	45	3000	90	600	600	

6. Environmental Characteristics

Environmental characteristics vary slightly depending upon the selected “Cooling Method”, as defined by the Part Number Identifier of Figure 1. Please note the differences in operating and storage conditions as defined herein.

6.1 Operating Specifications

Condition	Extruded Fin Heatsink Models (OZip-R****E****)	Fan-Cooled Extrusion Models (OZip-R****F****)	Fan-Cooled Crossflow Models (OZip-R****H****)	Liquid-Cooled Plate Models (OZip-R****L****)
Ambient Temperature	-40°C to +65°C (-40°F to +149°F)	-40°C to +65°C (-40°F to +149°F)	-40°C to +65°C (-40°F to +149°F)	Water based - 0°C to +65°C (+32°F to +149°F) Ethylene glycol (60/40) - -40°C to +65°C (-40°F to +149°F) Propylene glycol (60/40) - -40°C to +65°C (-40°F to +149°F) Other - Consult factory
Minimum Air/Coolant Flow	5.7 m^3 / minute (200 ft^3 / minute)	5.7 m^3 / minute (200 ft^3 / minute)	5.7 m^3 / minute (200 ft^3 / minute)	8.0 liters /minute (2.1 gallon / minute)
Humidity	0 – 95% RH non-condensing	0 – 95% RH non-condensing	0 – 95% RH non-condensing	0 – 95% RH non-condensing
Mechanical Shock	5g over 25ms half-sine (all axes & polarities)	5g over 25ms half-sine (all axes & polarities)	5g over 25ms half-sine (all axes & polarities)	5g over 25ms half-sine (all axes & polarities)
Pollution Degree Rating	Pollution Degree 3	Pollution Degree 3	Pollution Degree 3	Pollution Degree 3

6.2 Storage Specifications

Condition	Extruded Fin Heatsink Models (OZip-R****E****)	Fan-Cooled Extrusion Models (OZip-R****F****)	Fan-Cooled Crossflow Models (OZip-R****H****)	Liquid-Cooled Plate Models (OZip-R****L****)
Ambient Temperature	-55°C to +65°C (-67°F to +149°F)	-55°C to +65°C (-67°F to +149°F)	-55°C to +65°C (-67°F to +149°F)	Drained of fluid - -55°C to +65°C (-67°F to +149°F) Water filled - 0°C to +65°C (+32°F to +149°F) Ethylene glycol (60/40) - -40°C to +65°C (-40°F to +149°F) Propylene glycol (60/40) - -40°C to +65°C (-40°F to +149°F) Other - Consult factory
Thermal Shock	+/- 10°C (18°F) per second within ambient storage limits	+/- 10°C (18°F) per second within ambient storage limits	+/- 10°C (18°F) per second within ambient storage limits	+/- 10°C (18°F) per second within ambient storage limits
Mechanical Shock (packaged)	12.5g over 25ms half-sine (all axes & polarities)	12.5g over 25ms half-sine (all axes & polarities)	12.5g over 25ms half-sine (all axes & polarities)	12.5g over 25ms half-sine (all axes & polarities)
Ingress Protection	IP55 (Dust & water jet protected)	IP55 (Dust & water jet protected)	IP55 (Dust & water jet protected)	IP55 (Dust & water jet protected)

7. Interface Requirements

7.1 Earth (Safety) Ground

The heatsink or cold plate of the OZip-R Intelligent Power Module has been designated as chassis potential and shall require proper earth grounding in accordance with standards of the local electrical code.

7.2 Power Interfaces

7.2.1 Terminal Definition

There are five power connections utilizing M8 x 1.25 threaded stud terminals on the OZip-R IPM, as illustrated in Figure 12.

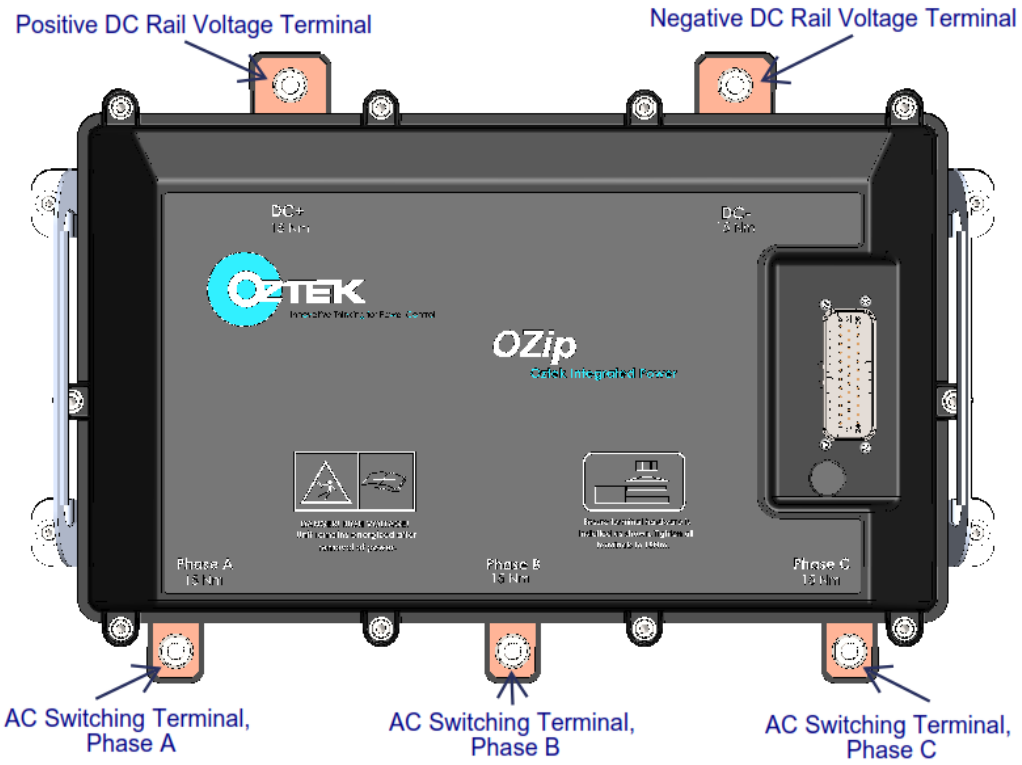


Figure 12: Power Interface Identification and Location

7.2.2 Hardware Stackup

Each power terminal is supplied with the appropriate mounting hardware to be used for electrical connection. The proper fastener stackup sequence, from the mounting tab upward, is as shown in Figure 13. Note that one, and only one, customer supplied compression terminal lug or formed buss bar may be used at each terminal. Torque targets of 15Nm (133 in-lb) must be satisfied to a tolerance of +/- 5%.

Figure 13: Power Terminal Hardware Stackup

7.2.3 Wire Sizing

It is assumed that any system application has been properly designed to account for the current carrying limitations of the associated wiring and allowable temperature rise. High current carrying wires are subject to forces that may require support to avoid long-term fatigue. Wire lengths must be minimized, and closely coupled to minimize current loops, while adequately spaced to allow heat dissipation so as to minimize temperature rise.

Table 6 provides general guidelines for wire sizing selections when run lengths are constricted to less than 15m (50 ft). Consult factory for recommendations as to wire sizing for installations with longer wiring requirements.

Table 6 – Wire Sizing Guidelines

RMS Current	Wire Size	
	Metric	US
105 A	10 mm^2	6 AWG
140 A	25 mm^2	4 AWG
190 A	35 mm^2	2 AWG
220 A	50 mm^2	1 AWG
260 A	50 mm^2	1/0 AWG
300 A	70 mm^2	2/0 AWG
350 A	95 mm^2	3/0 AWG
405 A	120 mm^2	4/0 AWG

7.2.4 External Circuit Protection

As defined by the application, a subset of the OZip-R Intelligent Power Module's power terminals must be protected externally by properly sized, fast acting semiconductor fuses or circuit breakers. This protection is not intended to safeguard any electronics, rather it is required to ensure the interruption of fault current in the event of operational failure. Consult Oztek with any questions pertaining to system protection.

7.3 Signal Interface Definition

7.3.1 Harness Plug

The harness plug used to mate to the signal interface header of the OZip-R IPM is TE Connectivity part number 776164-1, or its equivalent, shown in Figure 14. The plug is not provided with the unit.

Figure 14: Signal Interface Harness Plug Image

7.3.2 Harness Contact

The contacts used within the signal interface harness plug are TE Connectivity part number 770520-3, or equivalent, as shown in Figure 15. **NOTE**: Only gold plated sockets should be used for galvanic compatibility with the pins of the signal interface header on the OZip-R IPM. These contacts are not provided.

All specifications pertaining to wire size, insulation thickness, crimping requirements, etc. shall conform to those as defined in the TE Connectivity application specification 114-16016 for the AMPSEAL Automotive Plug Connector and Header Assembly. Signal assignment shall correspond to that for the appropriate receptacle header, as defined in Section 5.2.2, for the model of OZip-R IPM being employed.

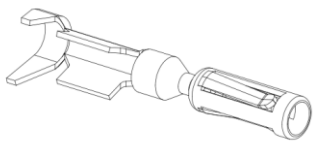


Figure 15: Harness Plug Socket Contact Illustration

7.3.3 Harness Contact Seal Plug

In order to maintain the unit's ingress protection as rated, seal plugs must be used at any unpopulated contact locations. The seal plug is TE Connectivity part number 770678-1, or its equivalent, as illustrated in Figure 16. These plugs are not provided.

Figure 16: Harness Seal Plug Image

7.3.4 Wire Strain Relief

It is highly recommended that the signal interface harness be constructed with a strain relief for mechanical integrity and longevity. Figure 17 shows an image of this housing, which is part number 776463-1 from TE Connectivity.

Figure 17: Image of Wire Strain Relief Housing

8. Installation

8.1 Mechanical Mounting

8.1.1 Extruded Fin Heatsink Models (OZip-R****E****)

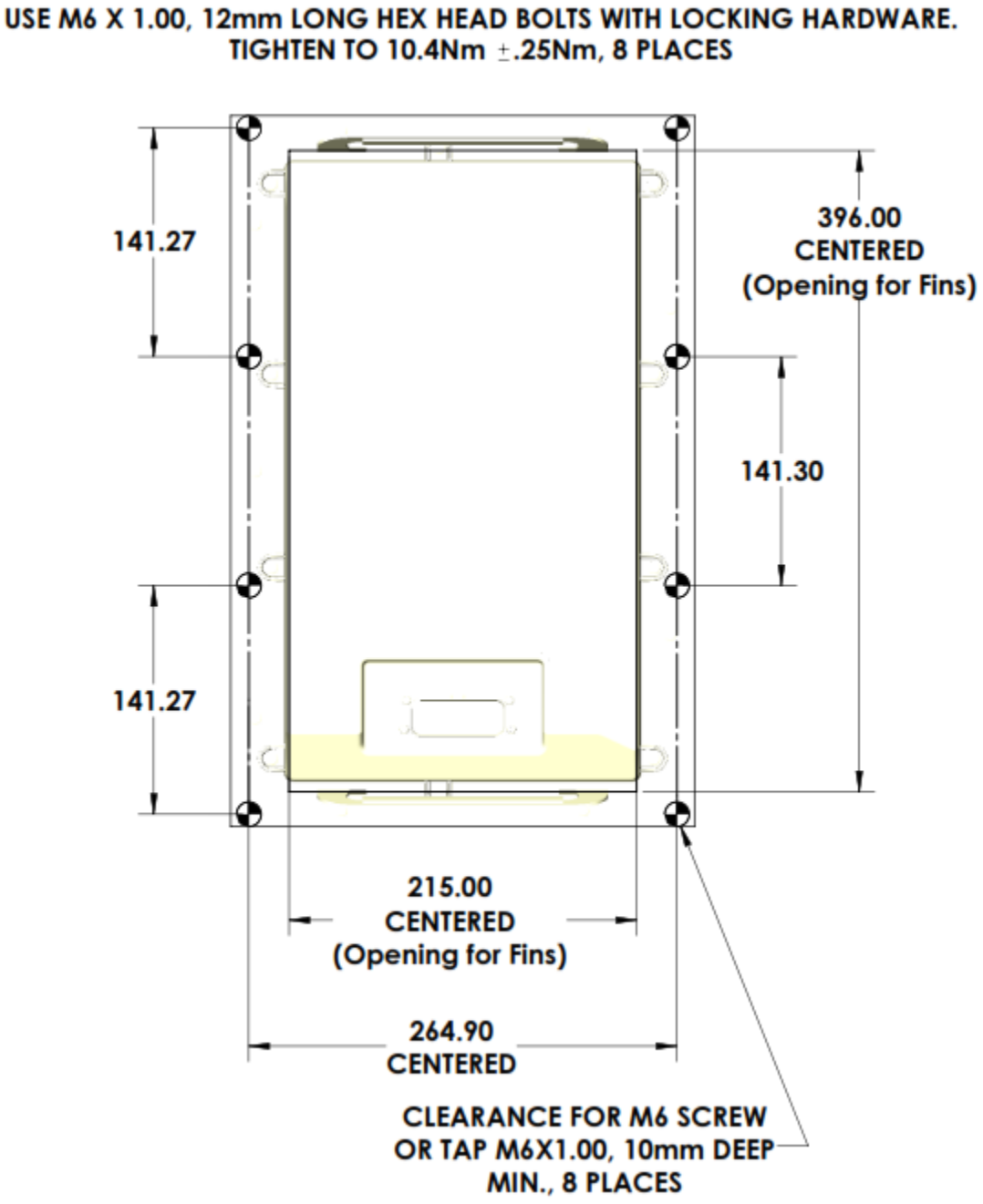


Figure 18: Mechanical Mounting Diagram, Models OZip-R****E****

8.1.2 Fan-Cooled Extrusion Models (OZip-R****F****)

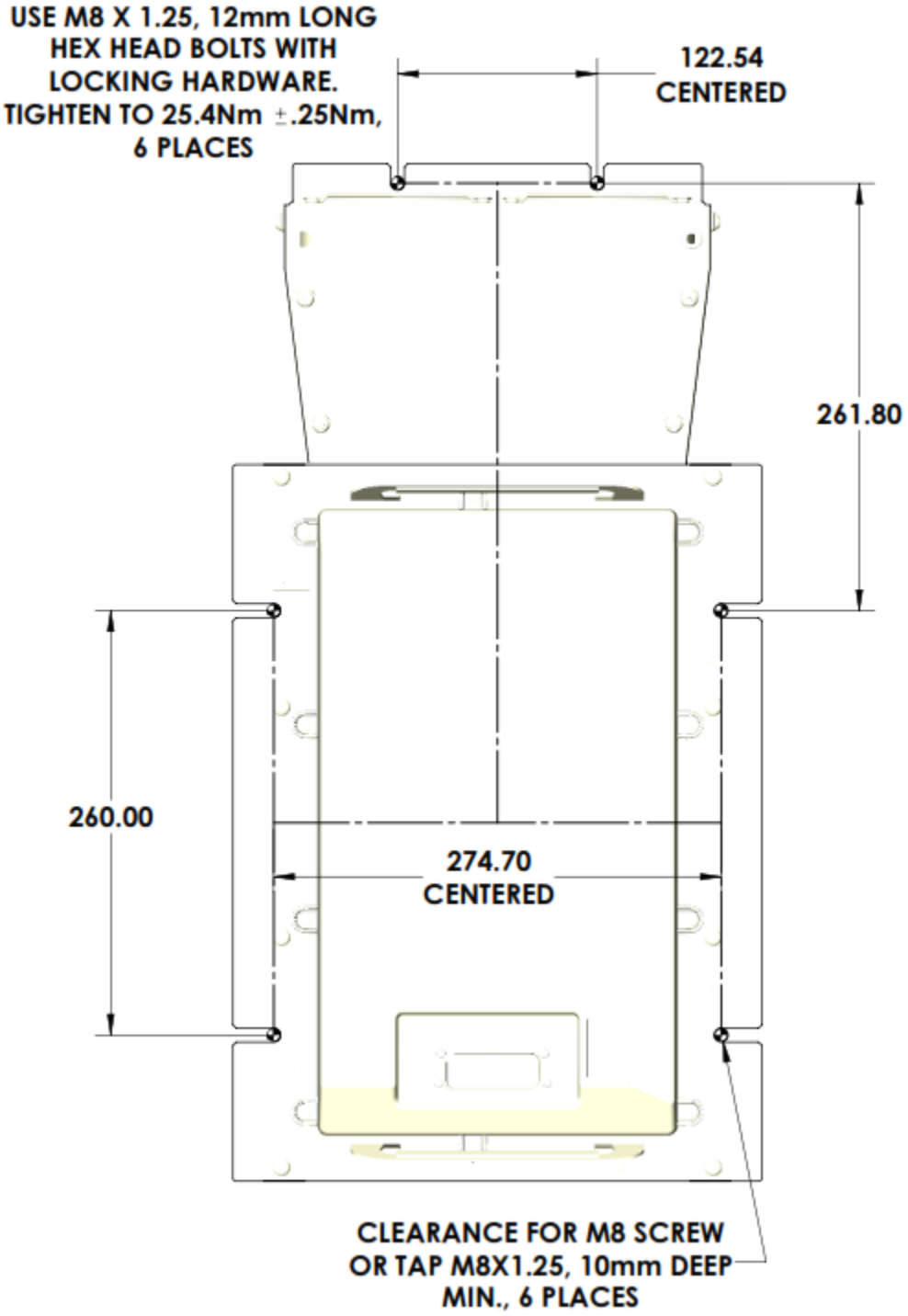


Figure 19: Mechanical Mounting Diagram, Models OZip-R****F****

8.1.3 Fan-Cooled Crossflow Models (OZip-R****H****)

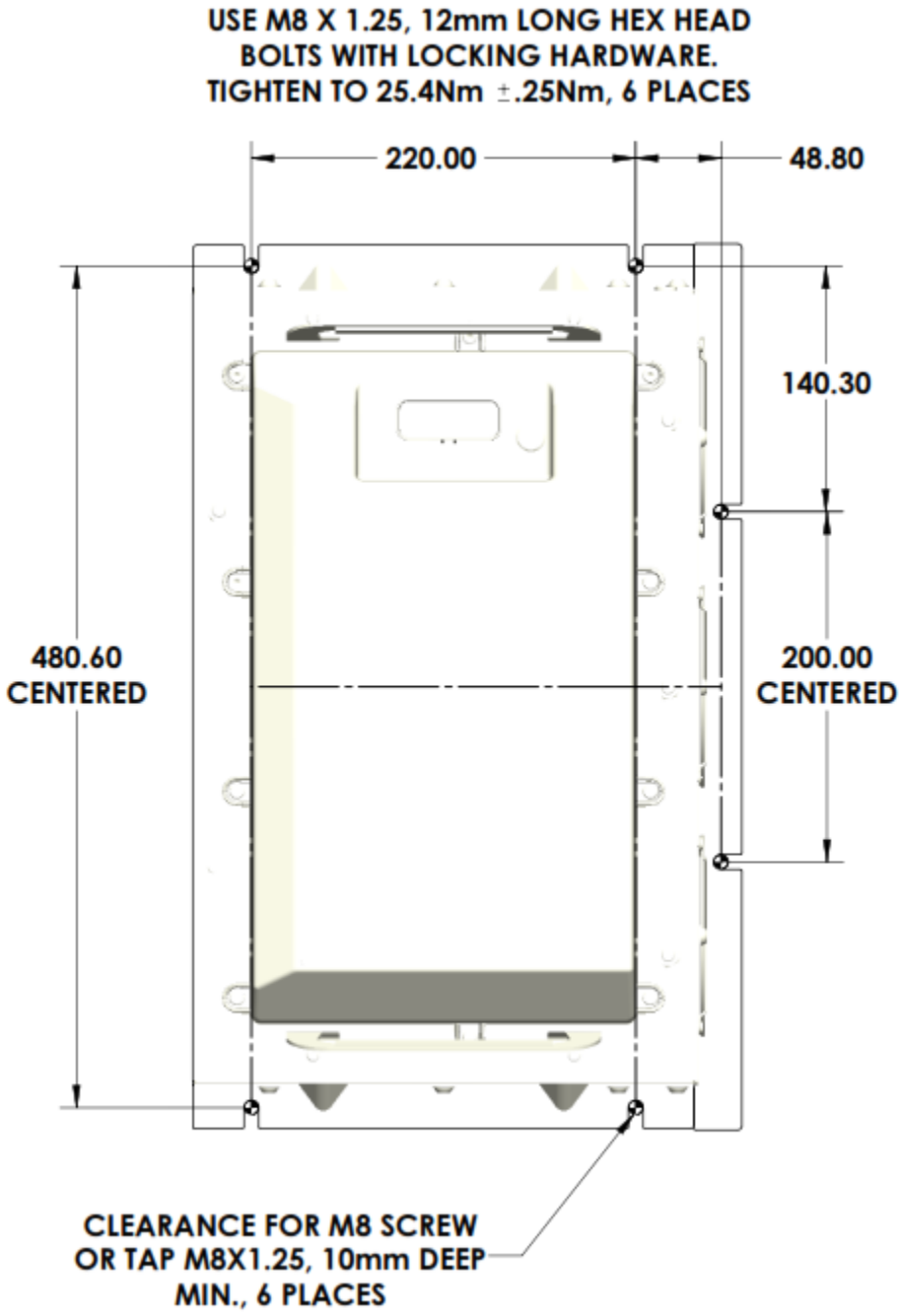


Figure 20: Mechanical Mounting Diagram, Models OZip-R****H****

8.1.4 Liquid-Cooled Plate Models (OZip-R****L****)

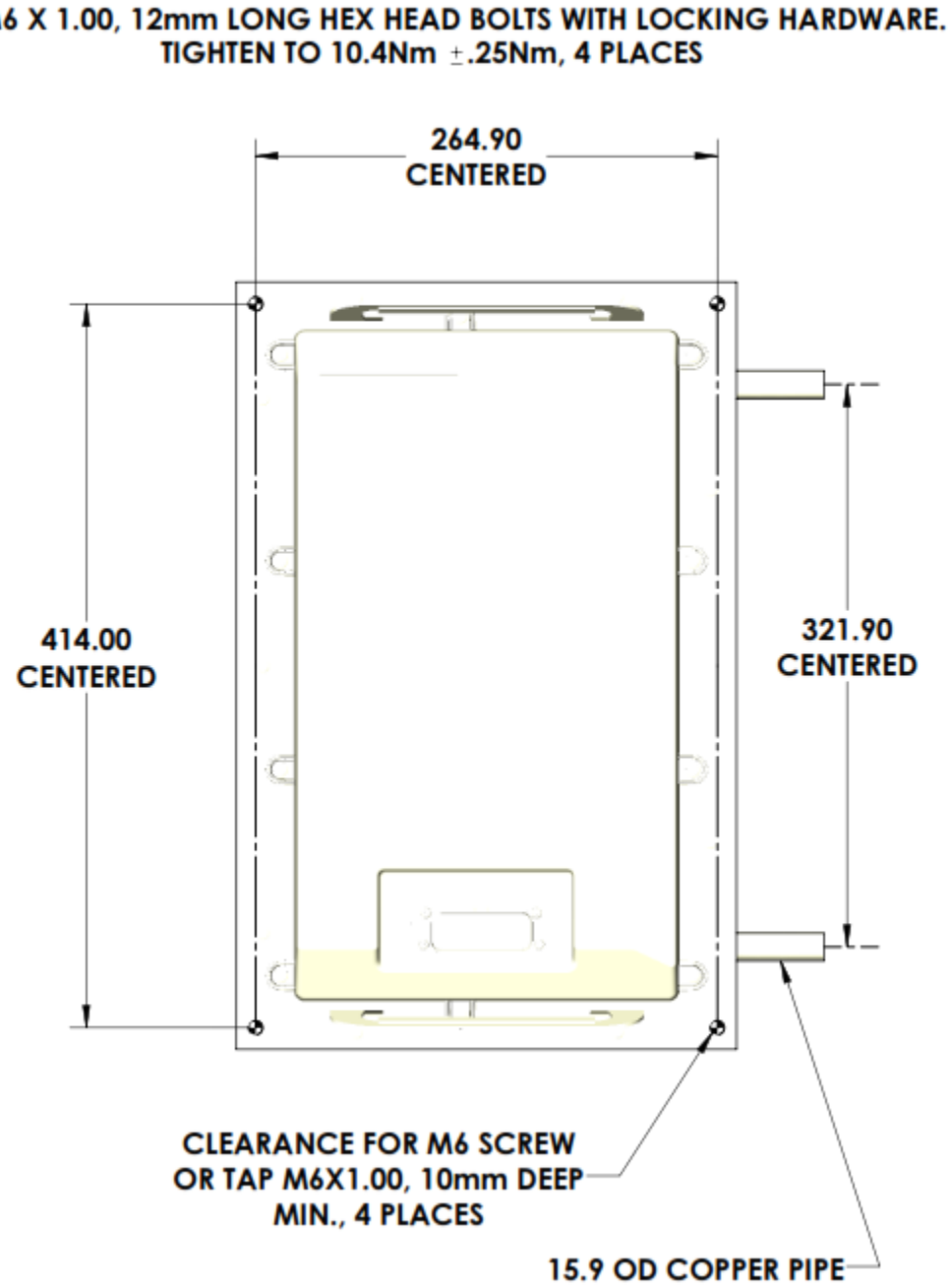


Figure 21: Mechanical Mounting Diagram, Models OZip-R****L****

8.2 Power Cable Connections

Provide an earth (safety) ground to the heatsink in accordance with local electrical codes, as described in Section 7.1.

DANGER

With no bias, AC, or DC voltage present, connect each power terminal using the proper torque level and hardware stackup as defined in Section 7.2.2. It is highly recommended that contact lubricant be applied prior to installation to extend cable interface longevity.

Note that no power factor correction capacitors should be connected at the AC power terminals.

8.3 Control Signal Wiring Connection

DANGER

With no bias, AC, or DC voltage present, engage the signal harness plug, as defined in Section 7.3, into the receptacle header of the OZip-R Intelligent Power Module, as defined in Section 5.2.1. Ensure that the latching mechanism catches so as to lock the plug in place. This may require higher than anticipated force due to the ingress protection sealing characteristics of the interface.

8.4 Fan Wiring Connections (if Equipped)

For those OZip-R IPM units with integral fans, models OZip-R****F**** and OZip-R****H**** as defined by the Part Number Identifier of Figure 1, this section describes how bias power and control is to be wired to the fans. The fans are provided with flying lead wires as follows:

- DC+ (typically yellow).
- DC- (typically black).
- PWM (typically green).

"DC-" is to be connected to the same reference as "BIAS-", as defined in Section 5.2.2. "DC+" is to be connected to the same source that provides power to "BIAS+" as defined in Section 5.2.2. Note that limitations on the fan supply rail constrain the maximum input voltage at "DC+/BIAS+" to 28 V_{DC}, relative to "DC-/BIAS-", for models using the integral fans (OZip-R****F**** and OZip-R****H****).

"PWM" is an optional connection to "FAN_PWM" as defined in Section 5.2.2 which the customer may use to dial back the fan speed when lightly loaded, reducing ambient noise and increasing fan longevity. If not used, the exposed lead must be electrically insulated and secured.

9. Servicing the Unit

The OZip-R IPM is not field serviceable. If the unit needs to return to the manufacturer for evaluation and possible repair, consult the Return Material Authorization Policy of this document as to how to proceed. In removing the OZip-R IPM from system installation, consult and follow the Electrical Safety precautions of Section 1.3.2.

10. Maintenance and Upgrade

Electrical connections should be regularly checked for mechanical integrity and thermal degradation. Airflow must be maintained unobstructed for maximum performance as specified for models OZip-R****~L****. Coolant must be regularly serviced for maximum performance in models OZip-R****L****.

11. Oztek Power Studio™ Tool

The Oztek Power Studio™ tool is a Microsoft Windows based Graphical User Interface (GUI), as shown in Figure 22, which can be used to easily configure and control the OZip-R IPM. The tool communicates with the unit over the CAN or RS-485 serial port and provides a simple, intuitive user interface. Some of the features provided by Power Studio™ include:

- Simple tabbed interfaces:
  - Dashboard
  - Configuration
  - Instrumentation
- Dashboard for inverter control and monitoring
- Inverter configuration control, including:
  - Editing configurations
  - Downloading/uploading configurations
  - Archiving multiple configuration files
- Firmware Update Utility

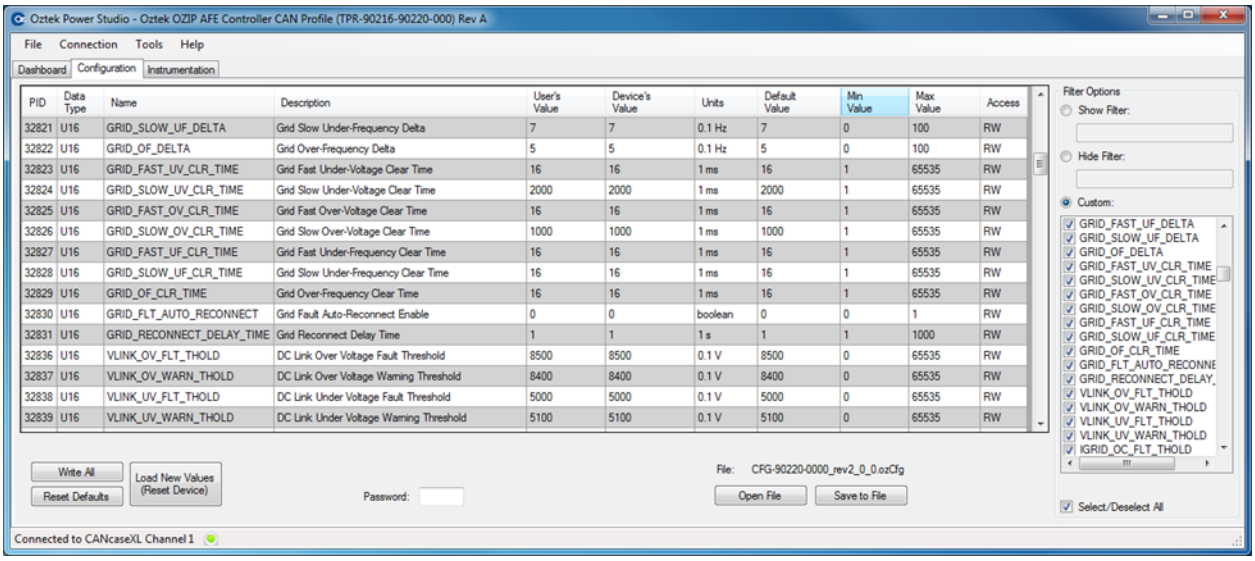


Figure 22: Oztek Power Studio™ GUI

For detailed information and operating instructions, please refer to UM-0052 Oztek Power Studio™ User's Manual.

Warranty and Product Information

Limited Warranty

What does this warranty cover and how long does it last? This Limited Warranty is provided by Oztek Corp. ("Oztek") and covers defects in workmanship and materials in your OZip-R IPM. This Warranty Period lasts for 18 months from the date of purchase at the point of sale to you, the original end user customer, unless otherwise agreed in writing. You will be required to demonstrate proof of purchase to make warranty claims. This Limited Warranty is transferable to subsequent owners but only for the unexpired portion of the Warranty Period. Subsequent owners also require original proof of purchase as described in "What proof of purchase is required?"

What will Oztek do? During the Warranty Period Oztek will, at its option, repair the product (if economically feasible) or replace the defective product free of charge, provided that you notify Oztek of the product defect within the Warranty Period, and provided that through inspection Oztek establishes the existence of such a defect and that it is covered by this Limited Warranty.

Oztek will, at its option, use new and/or reconditioned parts in performing warranty repair and building replacement products. Oztek reserves the right to use parts or products of original or improved design in the repair or replacement. If Oztek repairs or replaces a product, its warranty continues for the remaining portion of the original Warranty Period or 90 days from the date of the return shipment to the customer, whichever is greater. All replaced products and all parts removed from repaired products become the property of Oztek.

Oztek covers both parts and labor necessary to repair the product, and return shipment to the customer via an Oztek-selected non-expedited surface freight within the contiguous United States and Canada. Alaska, Hawaii and locations outside of the United States and Canada are excluded. Contact Oztek Customer Service for details on freight policy for return shipments from excluded areas.

How do you get service? If your product requires troubleshooting or warranty service, contact your merchant. If you are unable to contact your merchant, or the merchant is unable to provide service, contact Oztek directly at:

USA
Telephone: 603-546-0090
Email techsupport@oztekcorp.com

Direct returns may be performed according to the Oztek Return Material Authorization Policy described in your product manual.

What proof of purchase is required? In any warranty claim, dated proof of purchase must accompany the product and the product must not have been disassembled or modified without prior written authorization by Oztek. Proof of purchase may be in any one of the following forms:

- The dated purchase receipt from the original purchase of the product at point of sale to the end user
- The dated dealer invoice or purchase receipt showing original equipment manufacturer (OEM) status
- The dated invoice or purchase receipt showing the product exchanged under warranty

What does this warranty not cover? Claims are limited to repair and replacement, or if in Oztek's discretion that is not possible, reimbursement up to the purchase price paid for the product. Oztek will be liable to you only for direct damages suffered by you and only up to a maximum amount equal to the purchase price of the product.

This Limited Warranty does not warrant uninterrupted or error-free operation of the product or cover normal wear and tear of the product or costs related to the removal, installation, or troubleshooting of the customer's electrical systems. This warranty does not apply to and Oztek will not be responsible for any defect in or damage to:

a) The product if it has been misused, neglected, improperly installed, physically damaged or altered, either internally or externally, or damaged from improper use or use in an unsuitable environment
b) The product if it has been subjected to fire, water, generalized corrosion, biological infestations, or input voltage that creates operating conditions beyond the maximum or minimum limits listed in the Oztek product specifications including high input voltage from generators and lightning strikes
c) The product if repairs have been done to it other than by Oztek or its authorized service centers (hereafter "ASCs")
d) The product if it is used as a component part of a product expressly warranted by another manufacturer
e) The product if its original identification (trade-mark, serial number) markings have been defaced, altered, or removed
f) The product if it is located outside of the country where it was purchased
g) Any consequential losses that are attributable to the product losing power whether by product malfunction, installation error or misuse.

Disclaimer

Product

THIS LIMITED WARRANTY IS THE SOLE AND EXCLUSIVE WARRANTY PROVIDED BY OZTEK IN CONNECTION WITH YOUR OZTEK PRODUCT AND IS, WHERE PERMITTED BY LAW, IN LIEU OF ALL OTHER WARRANTIES, CONDITIONS, GUARANTEES, REPRESENTATIONS, OBLIGATIONS AND LIABILITIES, EXPRESS OR IMPLIED, STATUTORY OR OTHERWISE IN CONNECTION WITH THE PRODUCT, HOWEVER ARISING (WHETHER BY CONTRACT, TORT, NEGLIGENCE, PRINCIPLES OF MANUFACTURER'S LIABILITY, OPERATION OF LAW, CONDUCT, STATEMENT OR OTHERWISE), INCLUDING WITHOUT RESTRICTION ANY IMPLIED WARRANTY OR CONDITION OF QUALITY, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE TO THE EXTENT REQUIRED UNDER APPLICABLE LAW TO APPLY TO THE PRODUCT SHALL BE LIMITED IN DURATION TO THE PERIOD STIPULATED UNDER THIS LIMITED WARRANTY. IN NO EVENT WILL OZTEK BE LIABLE FOR: (a) ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING LOST PROFITS, LOST REVENUES, FAILURE TO REALIZE EXPECTED SAVINGS, OR OTHER COMMERCIAL OR ECONOMIC LOSSES OF ANY KIND, EVEN IF OZTEK HAS BEEN ADVISED, OR HAD REASON TO KNOW, OF THE POSSIBILITY OF SUCH DAMAGE, (b) ANY LIABILITY ARISING IN TORT, WHETHER OR NOT ARISING OUT OF OZTEK'S NEGLIGENCE, AND ALL LOSSES OR DAMAGES TO ANY PROPERTY OR FOR ANY PERSONAL INJURY OR ECONOMIC LOSS OR DAMAGE CAUSED BY THE CONNECTION OF A PRODUCT TO ANY OTHER DEVICE OR SYSTEM, AND (c) ANY DAMAGE OR INJURY ARISING FROM OR AS A RESULT OF MISUSE OR ABUSE, OR THE INCORRECT INSTALLATION, INTEGRATION OR OPERATION OF THE PRODUCT. IF YOU ARE A CONSUMER (RATHER THAN A PURCHASER OF THE PRODUCT IN THE COURSE OF A BUSINESS) AND PURCHASED THE PRODUCT IN A MEMBER STATE OF THE EUROPEAN UNION, THIS LIMITED WARRANTY SHALL BE SUBJECT TO YOUR STATUTORY RIGHTS AS A CONSUMER UNDER THE EUROPEAN UNION PRODUCT WARRANTY DIRECTIVE 1999/44/EC AND AS SUCH DIRECTIVE HAS BEEN IMPLEMENTED IN THE EUROPEAN UNION MEMBER STATE WHERE YOU PURCHASED THE PRODUCT. FURTHER, WHILE THIS LIMITED WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, YOU MAY HAVE OTHER RIGHTS WHICH MAY VARY FROM EU MEMBER STATE TO EU MEMBER STATE OR, IF YOU DID NOT PURCHASE THE PRODUCT IN AN EU MEMBER STATE, IN THE COUNTRY YOU PURCHASED THE PRODUCT WHICH MAY VARY FROM COUNTRY TO COUNTRY AND JURISDICTION TO JURISDICTION.

Return Material Authorization Policy

Before returning a product directly to Oztek you must obtain a Return Material Authorization (RMA) number and the correct factory "Ship To" address. Products must also be shipped prepaid. Product shipments will be refused and returned at your expense if they are unauthorized, returned without an RMA number clearly marked on the outside of the shipping box, if they are shipped collect, or if they are shipped to the wrong location.
When you contact Oztek to obtain service, please have your instruction manual ready for reference and be prepared to supply:

- The serial number of your product
- Information about the installation and use of the unit
- Information about the failure and/or reason for the return
- A copy of your dated proof of purchase

Return Procedure

Package the unit safely, preferably using the original box and packing materials. Please ensure that your product is shipped fully insured in the original packaging or equivalent. This warranty will not apply where the product is damaged due to improper packaging. Include the following:

- The RMA number supplied by Oztek clearly marked on the outside of the box.
- A return address where the unit can be shipped. Post office boxes are not acceptable.
- A contact telephone number where you can be reached during work hours.
- A brief description of the problem.

Ship the unit prepaid to the address provided by your Oztek customer service representative.

If you are returning a product from outside of the USA or Canada - In addition to the above, you MUST include return freight funds and you are fully responsible for all documents, duties, tariffs, and deposits.

Out of Warranty Service

If the warranty period for your product has expired, if the unit was damaged by misuse or incorrect installation, if other conditions of the warranty have not been met, or if no dated proof of purchase is available, your unit may be serviced or replaced for a flat fee. If a unit cannot be serviced due to damage beyond salvation or because the repair is not economically feasible, a labor fee may still be incurred for the time spent making this determination.

To return your product for out of warranty service, contact Oztek Customer Service for a Return Material Authorization (RMA) number and follow the other steps outlined in "Return Procedure".

Payment options such as credit card or money order will be explained by the Customer Service Representative. In cases where the minimum flat fee does not apply, as with incomplete units or units with excessive damage, an additional fee will be charged. If applicable, you will be contacted by Customer Service once your unit has been received.