INSTRUCTION MANUAL FOR

500A/102A/152A/202A
POWER SUPPLY

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TDK-Lambda Americas

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ONE YEAR WARRANTY

TDK-Lambda Americas, Inc. (405 Essex Road, Neptune, N.J. 07753), warrants that the unit is free from defects in material or workmanship for a period of ONE YEAR from the date of initial shipment. TDK-Lambda Americas Inc. will service and, at its option, repair or replace parts which prove to be defective. This will be done free of charge during the stated warranty period. This warranty excludes defects resulting from misuse, unauthorized modification, operation outside the environmental or safety specifications of the power supply, or improper site preparation or maintenance. The customer shall contact TDK-Lambda Americas Inc., for warranty service or repair as described in the RETURNING EQUIPMENT section. The customer shall prepay shipping charges. If the unit is covered under the foregoing warranty, then TDK-Lambda Americas Inc. shall pay the return shipping charges.

The "WARRANTY", "CLAIM FOR DAMAGE IN SHIPMENT", and "RETURNING EQUIPMENT" information applies to equipment purchased directly from TDK-Lambda Americas Inc. End users receiving equipment from a third party should consult the appropriate service organization for assistance with these issues.

THIS LIMITED WARRANTY IS IN LIEU OF, AND TDK-LAMBDA AMERICAS INC. DISCLAIMS AND EXCLUDES, ALL OTHER WARRANTIES, STATUTORY, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR OF CONFORMITY TO MODELS OR SAMPLES.

CERTIFICATION

All test and measuring equipment used by TDK-Lambda Americas Inc. for Final Acceptance Testing are traceable to primary standards certified by the National Institute of Standards and Technology.

LETHAL VOLTAGES PRESENT!

All power supplies contain hazardous voltage and energy. The power supply must only be operated by qualified personnel who have read this operator's manual and are familiar with the operation, hazards and application of the power supply. Proper care and judgment must always be observed.

1. Before connecting input AC power, ensure all covers are in place and securely fastened. Ensure the required safety ground to chassis is installed and sufficient cooling is supplied.
2. Proper grounding from the input AC power is required to reduce the risk of electric shock, and to comply with safety agency and code requirements.
3. Use extreme caution when connecting input AC power. Only apply the input voltage specified on the rating label.
4. Use extreme caution when connecting any high voltage cables. Never handle any output cables when the power supply is operating.
5. After a power supply is switched OFF, its output section will retain a charge which may be lethal. Allow sufficient time for self-discharge before handling anything connected to the output. The discharge time specified in the Safety Notes does *NOT* include extra time required to discharge the energy stored in the user's load.
6. When user serviceable fuses are present, always replace fuses with the same type and Volt/Amp rating.
7. Never attempt to operate the power supply in any manner not described in this manual.
8. Never remove DANGER or WARNING labels from the power supply. Replace lost or damaged labels immediately. Contact TDK-Lambda Americas Customer Service for replacement labels.
9. The power supply may be serviced only by TDK-Lambda Americas Inc. factory qualified service personnel. Breaking the warranty seal will void the warranty. Prior to opening the power supply, contact TDK-Lambda Americas Inc. Customer Service for a written Service Waiver and a replacement warranty seal.

TDK-Lambda

MANUFACTURER'S PRODUCT DECLARATION

INTENDED PURPOSE (USE)

The Power Supplies described by this manual are defined by TDK-Lambda Americas Inc. as a component for use in the composition of an apparatus as defined in Article 1 (1) of the EMC Directive (89/336/EEC). These products, as individual components, do not perform in themselves a direct function for the user of the end product. They are not intended to be placed on the market with a direct function to a final user! As such, the products described by this manual are not subject to the provisions of the EMC Directive (89/336/EEC, with amendment 92/31/EEC).

The products described by this manual are intended for incorporation into a final product by a professional assembler. It is the responsibility of the assembler to ensure that the final apparatus or system incorporating our products complies with all relevant EMC standards for that final product.

OPERATING ENVIRONMENT

The operating environment as defined by TDK-Lambda Americas Inc., for the products described by this manual is stated as follows:

The Power Supplies described by this manual are intended for use in a protected industrial environment or in proximity to industrial power installations. These locations are often referred to as industrial locations containing establishments that are not connected to the low voltage public mains network.

Industrial locations are characterized by the existence of one or more of the following conditions:

1) industrial, scientific and medical (ISM) apparatus are present;
2) heavy inductive or capacitive loads are frequently switched;
3) currents and associated magnetic fields are high;
4) location supplied by their own transformer.

These components are not intended for connection to a public mains network, but are intended to be connected to a power network supplied from a high or medium-voltage transformer dedicated for the supply of an installation feeding manufacturing or similar operations. They are suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

TDK-Lambda

Description of symbols used in product labeling

SYMBOL	PUBLICATION	DESCRIPTION
	EC Council Directive 93/68/EEC	European Community Conformity Assessment Product Mark
	IEC 348	Attention, consult Accompanying documents
	IEC 60417-1-5036	Dangerous voltage
	IEC 60417-1-5019	Protective earth (e.g. power line earth ground)
	IEC 60417-1-5017	Functional earth (e.g. chassis ground)
	IEC 60417-1-5134	Electrostatic Discharge (ESD) Sensitive Device

ELECTRICAL STANDARDS

All company primary standards are either certified or are traceable to certification by the National Institute of Standards and Technology.

CLAIM FOR DAMAGE IN SHIPMENT

This instrument received comprehensive mechanical and electrical inspection before shipment. Immediately upon receipt from the carrier, and before operation, this instrument should be inspected visually for damage caused in shipment. If such inspection reveals damage in any way, a claim should be filed with the carrier. A full report of damage should be obtained by the claim agent and this report should be forwarded to us. We will then provide a disposition of the equipment and arrange for repair or replacement.

When referring to this equipment, always include the model and serial numbers.

The "WARRANTY", "CLAIM FOR DAMAGE IN SHIPMENT", and "RETURNING EQUIPMENT" information applies to equipment purchased directly from TDK-Lambda Americas Inc. End users receiving equipment from a third party should consult the appropriate service organization for assistance with these issues.

RETURNING EQUIPMENT

Before returning any equipment to the factory, the following steps shall be taken.

1. Notify TDK-Lambda Americas Inc. at (732) 795-4100 or follow the instructions at https://rma.us.lambda.tdk.com/phv/Neptune_RMA. Give a full description of the difficulty including the model and serial number of the unit in question. Upon receipt of this information, we will assign a Return Material Authorization (RMA) number and provide shipping instructions.
2. The customer shall prepay shipping charges. Equipment returned to us must be packed in a manner to reach us without damage. The shipping container must be marked with the RMA number in an area approximate to the shipping label with numbers that are easy to read. All returned units that do not show the RMA number on the outside of the container will be refused.

   If the equipment is repaired within the warranty agreement, than TDK-Lambda Americas Inc. shall pay for the return shipping to the customer.
3. For non-warranty repairs, we will submit a cost estimate for your approval prior to proceeding. The customer shall pay return shipping charges.

MECHANICAL INSTALLATION

Most power supplies are heavy and, when rack mounted, they should be supported by rails along the sides of the supply from front to rear. The rails must adequately support the unit and not block airflow. Do not support the power supply from the front panel only.

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CHAPTER 1 INTRODUCTION

1.1 DESCRIPTION

The Series 500A/102A/152A/202A are High Voltage Switching Power Supplies designed specifically for charging capacitors in laser systems and other pulsed power applications. The 500A provides 500 J/s. the 102A is 1000 J/s, 152A is 1,500 J/s, and the 202A provides 2000 J/s of average power and can be paralleled indefinitely for higher total system power. TDK-Lambda Americas Inc. also offers the 402 Series, 802 Series, and 303 Series rated at 4,000, 8,000 and 30,000 J/s respectively.

The 500A/102A/152A/202A power supplies incorporate a new high-frequency IGBT parallel resonant inverter topology for efficient generation of the output power. A high-performance control module precisely regulates the output voltage, automatically compensating for line, load, temperature, and rep rate variations. Normal external fault conditions such as line dropout open or short circuit load, HV arc and over-temperature will not damage the unit. The latest development in the parallel resonant inverter topology and control circuitry also drastically improves pulse-to-pulse repeatability by reducing the ripple or “bucket effect” even at very high pulse repetition frequencies. The output voltages of the 500A/102A/152A/202A supplies are fully adjustable over each range.

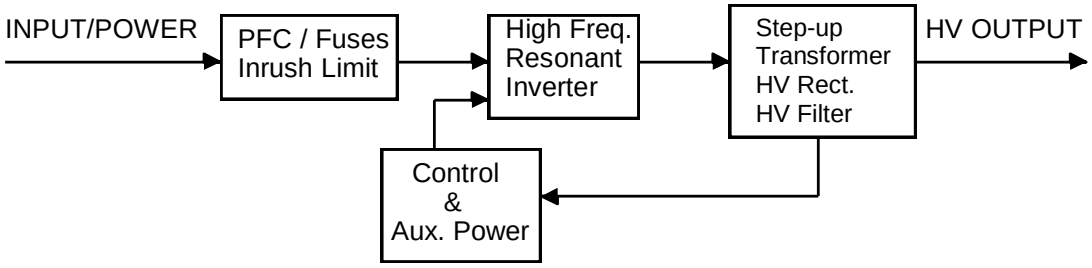


Figure 1-1 500A/102A/152A/202A Block Diagram

CHAPTER 2 SPECIFICATIONS

2.1 AVERAGE CHARGING RATE

500J/s, 1000J/s, 1500J/s, 2000J/s at rated Output Voltage

2.2 PEAK CHARGING RATE

550J/s, 1100J/s, 1650J/s, 2200J/s at rated Output Voltage

2.3 NUMBER OF MODELS IN SERIES

12 Standard (others at extra cost)

2.4 STANDARD VOLTAGE RANGES

1kV, 1.5kV, 2kV, 3kV, 4kV, 5kV, 5kV, 10kV, 15kV, 20kV, 30kV and 40kV. All models continuously variable from 0 to 100% of rated output voltage.

2.4.1 LINEARITY

Linear to within 1% of full scale.

2.4.2 ACCURACY

1% of rated.

2.5 POLARITY

Available as fixed Positive or Negative

2.6 HIGH VOLTAGE ASSEMBLY

Insulating Medium/Cable

Voltage	Medium	Output Cable
1kV to 6kV	Air	Coax. RG59
10kV to 40kV	Oil	12 AWG, HV Silicon

Table 2-1: High Voltage Cable

2.7 INPUT CONNECTOR

VDE, UL approved.

2.8 INPUT CHART

Input Voltage selective by Terminal block position

Input Voltage (VAC)		Current (No PFC)			Current (PFC)			
Nameplate Range	Design Range	500A	102A	152A	500A	102A	152A	202A
230 50/60Hz	180-253 50/60Hz	5A	10A	14.5A	3.5A	6.6A	10A	13.5
115 50/60Hz	90-140 50/60Hz	10A	20A	N/A	7A	N/A	N/A	N/A
*Note: Input current ratings given are maximum when output Repetition Rate is =>10Hz Consult Factory if model used at less than 10Hz.								

Table 2-2: Input Voltage Chart

2.9 POWER FACTOR

	Non PFC	PFC
All models	0.65	0.98

Table 2-3 Power Factor

2.10 EFFICIENCY

Better than 85%

2.11 STORED ENERGY

Less than 0.5 Joules all models

2.12 STABILITY

0.2% per hour after 1 hour warm up

2.13 PULSE TO PULSE REPEATABILITY

±0.2% to 300Hz. For higher repetition rates, consult factory

2.14 TEMPERATURE COEFFICIENT

100ppm per ºC

2.15 AMBIENT TEMPERATURE

Storage -40 to +85ºC. Operating -20 to +45ºC

2.16 HUMIDITY

90%, non-condensing

2.17 PROTECTION

The power supply is protected against Open Circuits, Short Circuits, Overloads and Arcs

2.18 AGENCY APPROVALS

The 500A, 102A, 152A power supplies are safety approved by UL to UL 60601-1: 1990+A1+A2: 1995. All of the standard supplies with output voltages between 1kV and 40kV with or without active PFC are certified UL to meet the safety requirements of UL60601-1 with the following exceptions.
1. Conducted RFI to be assessed in the installed application.
2. IEC601-1 approved isolation transformer is required to meet leakage current.

2.19 TRANSIENT LINE PROTECTION

Meets requirements of IEC 801-4, 801-5

2.20 ESD

All Remote Control Functions meet requirements of IEC 801-2

2.21 NOTE FOR PFC UNITS

When High Voltage is enabled by using either the “HV Enable” Line or deactivation of the “Inhibit” Line the power supply will reach normal operation mode (and therefore all other published specifications) within 50ms.

2.22 ACCESSORIES

- Detachable 8 foot (2.4 meter) HV Cable
- 15 pin “D” plug mating control connector
- Operating Manual

2.23 OPTIONS

2.23.1 Suffix –LH

“Low Inhibit” - A +10 to 15 volt (high) signal will allow power supply operation. A 0 to +1.5 volt (low) signal will inhibit the supply.

2.23.2 SUFFIX –EN

“Low Enable” - A +10 to 15 volt (high) signal will disable power supply operation. A 0 to +1.5 volt (low) signal will enable the supply.

2.23.3 Suffix -5V

0 to +5 volt voltage (0 to full-scale output) programming. For controlling the unit VPROGRAM is 0-5V (remote pin 5). The value for VPEAK is 0-5.5V (remote pin 7) and the value for VANALOG is 0-5.5V (remote pin 8).

2.23.4 Suffix –LP

Latching overload protection, Load fault triggers a Summary Fault (load fault will clear) and shuts the unit down. Requires HV reset after an overload Fault.

2.23.5 SUFFIX -110

100 to 120 VAC input option (availability limited).

2.24 ORIENTATION

Power supplies >6kV with a oil-filled H.V. section must be operated in an upright position. i.e., with the mounting bracket parallel to the ground plane.

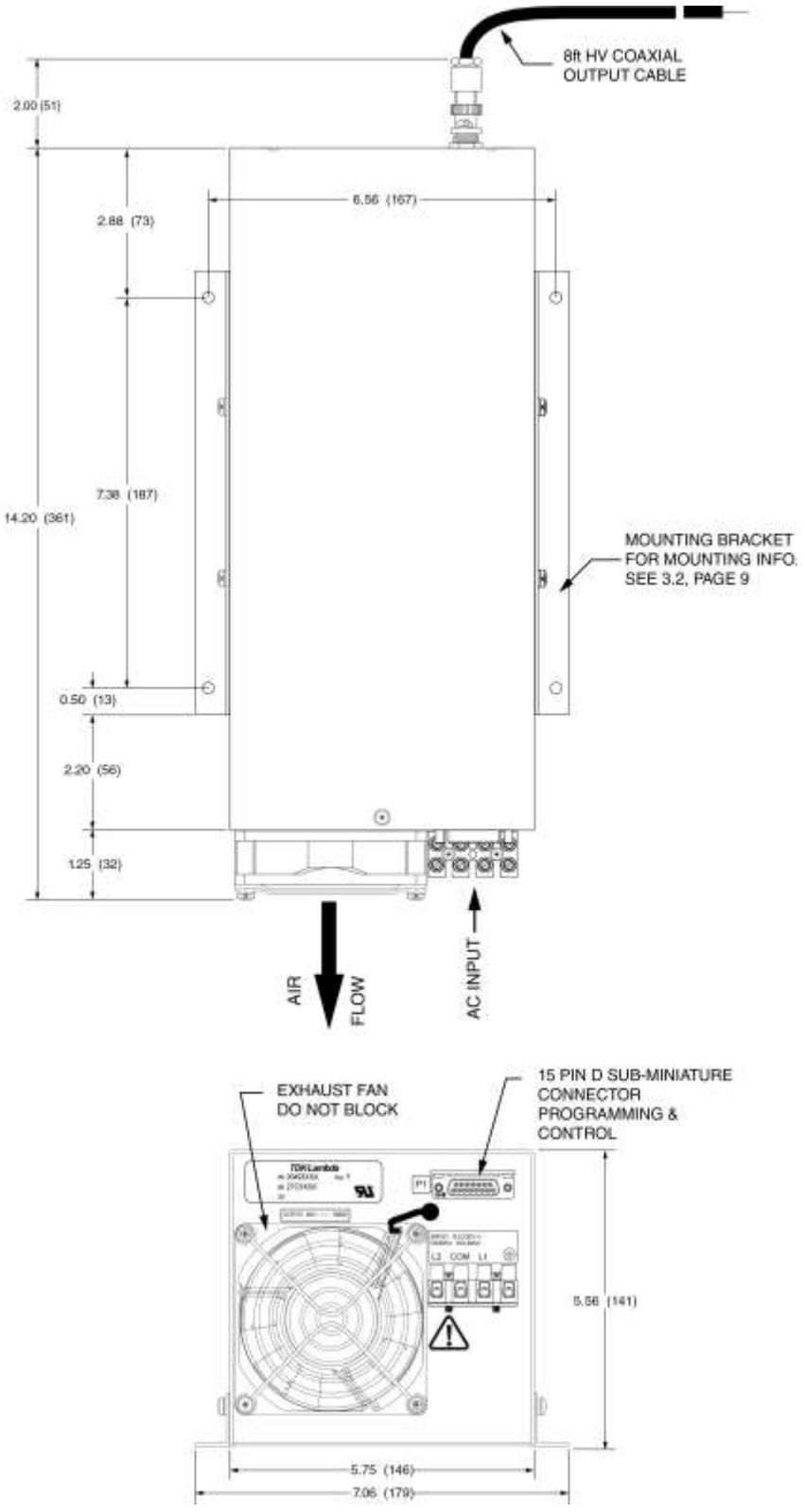


Figure 2-1 Mechanical Dimensions for 500A, 102A, 152A Outputs up to 6kV (for grounding instructions see SECTION 3.6)

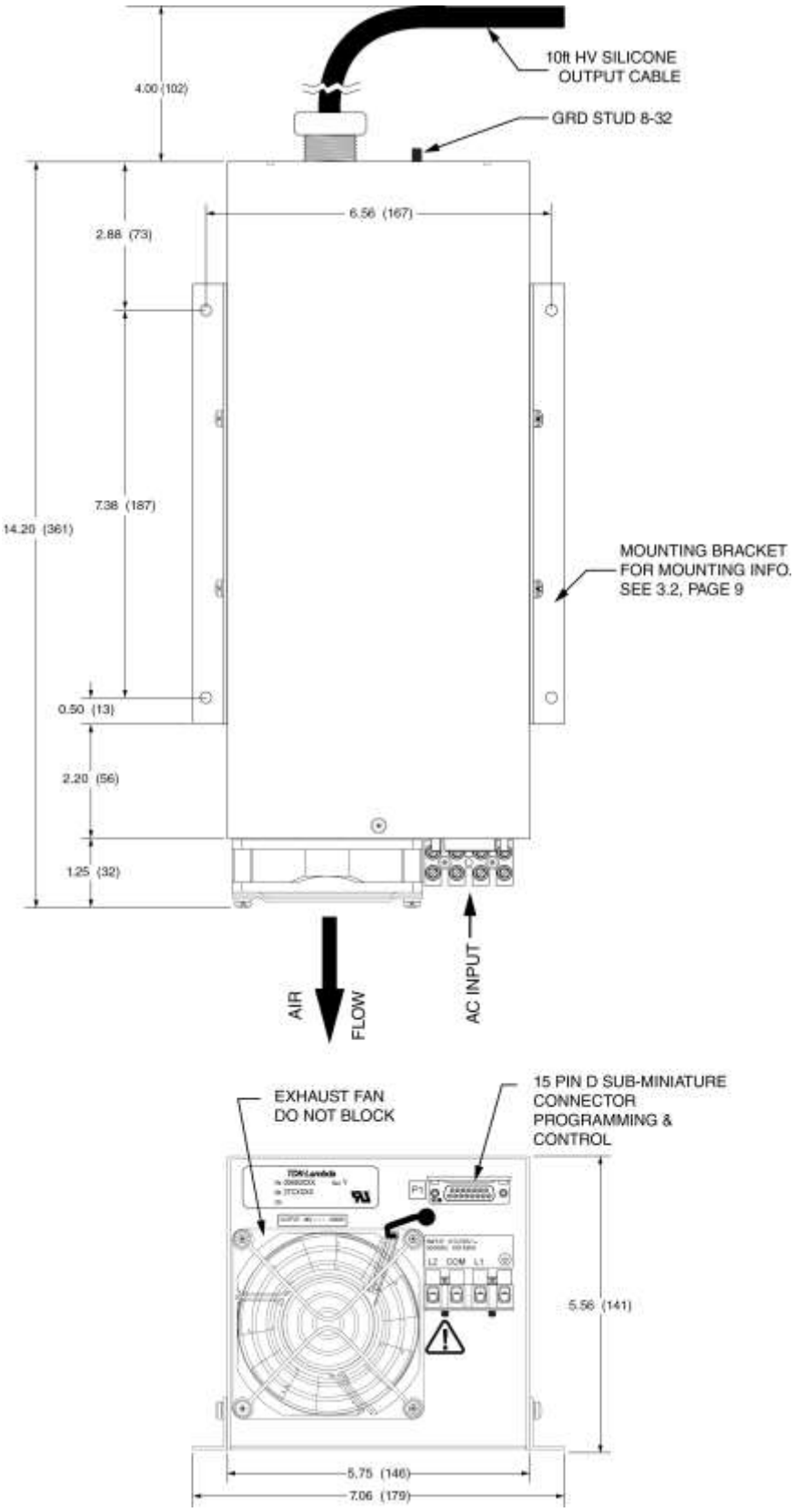


Figure 2-2 Mechanical Dimensions for 500A, 102A, 152A Outputs from 7kV to 40kV (for grounding instructions see SECTION 3.6)

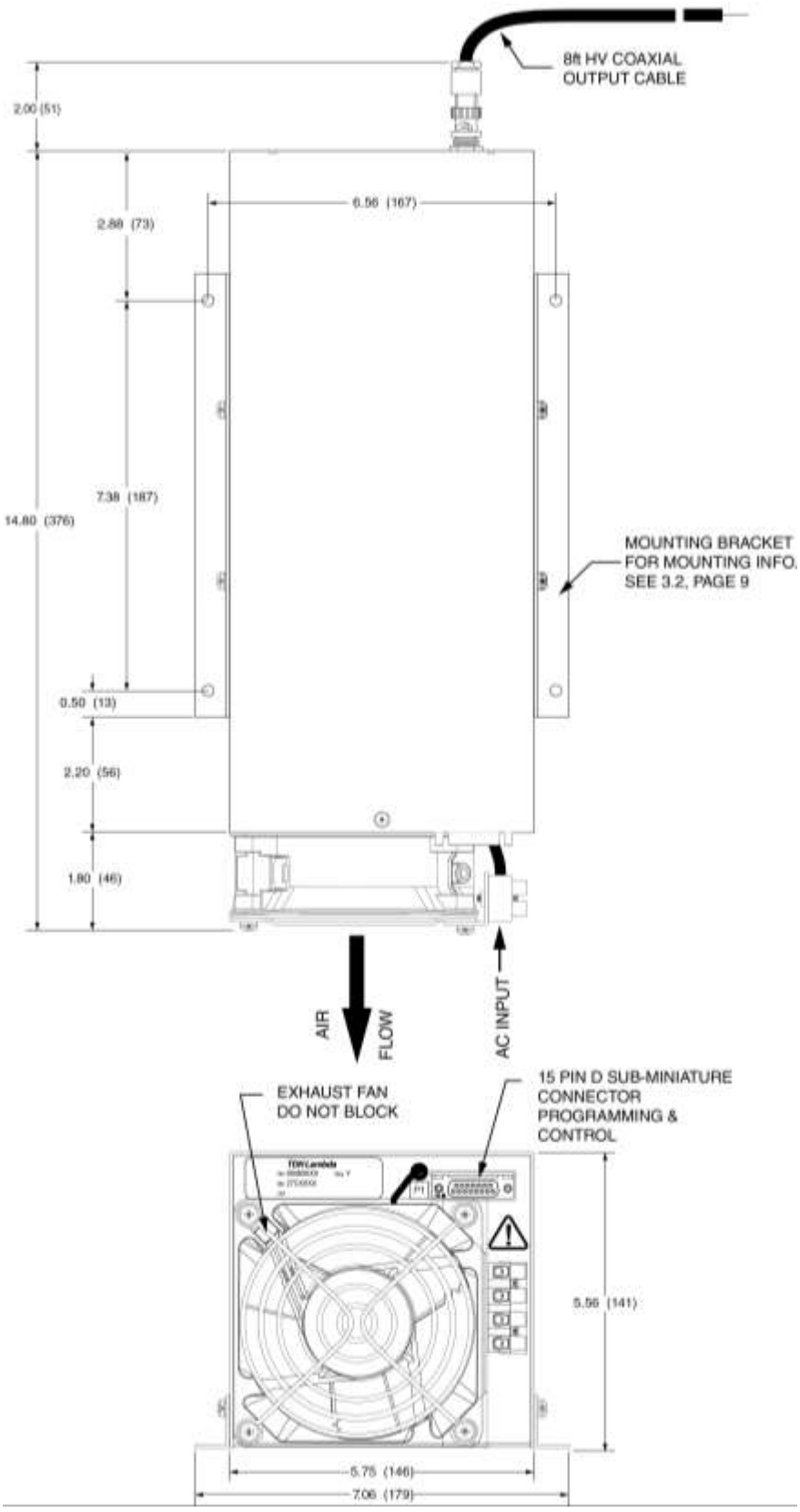


Figure 2-3 Mechanical Dimensions for 202A Outputs up to 6kV (for grounding instructions see SECTION 3.6)

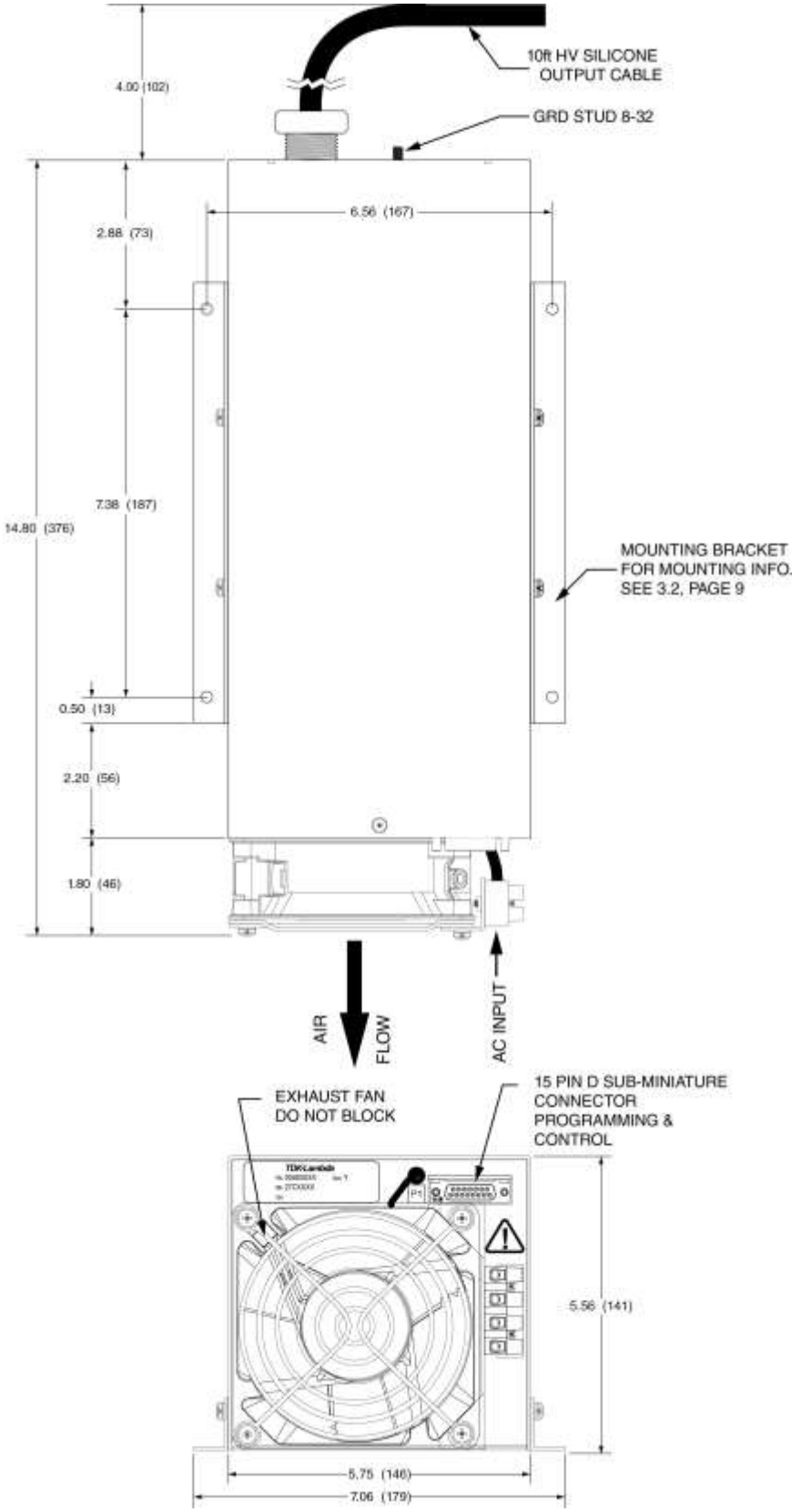


Figure 2-4 Mechanical Dimensions for 202A Outputs from 7kV to 40kV (for grounding instruction see SECTION 3.6)

CHAPTER 3 INSTALLATION

3.1 INITIAL INSPECTION

The shipping container contains the following items: power supply, HV output cable, male 15-pin “D” remote control mating connector, mounting bracket and operator’s manual. Examine the items immediately for damage. Locate the serial number label on the end of the power supply and verify the model number, the input voltage rating and the output voltage rating and polarity. In the event of any damage promptly notify the transportation company and the TDK-Lambda Americas Inc. Customer Service Department.

3.2 MOUNTING AND COOLING REQUIREMENTS

The power supply can be mounted by the chassis support brackets (see Figure 2-1, 2-2, 2-3 and 2-4 for details). The mounting brackets are attached to the supply using the four PHMS 8-32NC X 0.250 screws included. Using longer screws may internal components to ground, causing permanent damage to power supply. The power supply can also operate on a bench or table top. Power supplies above 6kV with an oil-filled H.V. section must be operated in an upright position i.e. mounting bracket parallel to ground plane. In all cases adequate clearances must be provided for proper air flow and cable bends. Keep the minimum HV cable bend radius greater than 4 inches (102mm) to minimize stress on the insulation and at least 4 inches (102mm) of clearance at the inlet of the power supply and 2 inches (51mm) at the sides.

When operating in an enclosed system, care must be taken to ensure the ambient inlet air to the power supply does not exceed the maximum operating temperature of 45ºC.

3.3 INPUT AC POWER

Proper grounding from the input AC power is required to reduce the risk of electric shock. The metal chassis of the power supply is grounded through the green earthing wire at the input AC power terminal block. A protective ground connection by way of the grounding conductor in the input terminal is essential for safe operation. Use extreme caution when connecting input AC power and never apply the incorrect input power.

The PFC version and version without PFC should be connected as explained in the following 2 paragraphs.

A. Version with no PFC.

For this version, the supply may be connected to either 115VAC for 230VAC input voltage (See table 2.2 for availability). These connections are shown in Figure 3-1.

For 115VAC connect the input line wires to L1 and COM terminals.

For 230VAC connect the input wires to L2 and COM terminals.

B. Version with PFC.

The PFC version connection is shown in Figure 3-2. Connect the input voltage line wires to L2 and COM terminals.

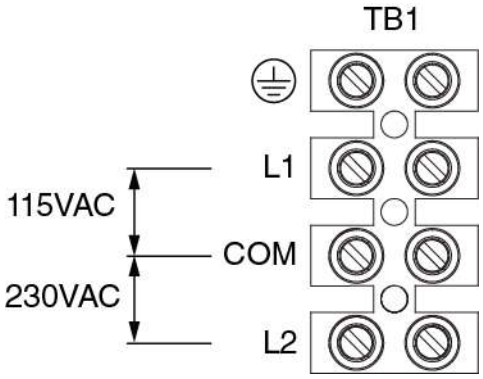


Figure 3-1 Input AC Power Connection NON-PFC Version

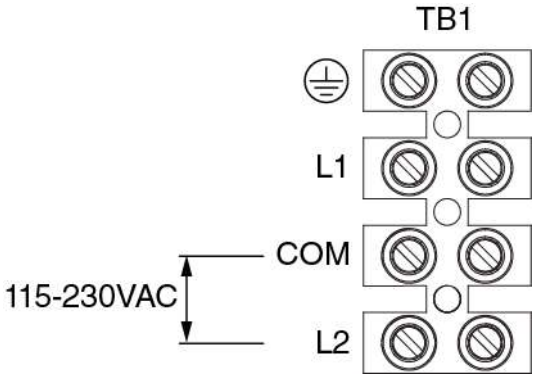


Figure 3-2 Input AC Power Connection, PFC Version

The 500A, 102A, 152A power supplies are safety approved by UL to UL60601-1. An IEC601-1 approved isolation transformer is required to meet leakage current.

3.4 POWER CORD SPECIFICATION:

Use wire with minimum .064 inches (1.6mm) diameter and 600 V insulation.

3.5 CONNECTING HIGH VOLTAGE OUTPUT

POTENTIAL LETHAL VOLTAGE

Ensure that the power supply is off and disconnected from the input power and never operate the power supply without a load capacitor. Make sure that all load capacitors are discharged and shorted to ground before making any connections. TDK-Lambda Americas Inc. recommends the use of safety dump switches in high voltage discharge circuits.

Never handle the HV cable during operation.

This power supply is designed to operate with a capacitive load. Operation of the power supply without an external load capacitor may result in damage to internal circuitry.

Always use the HV connector and cable provided with the power supply or an equivalent substitute provided by TDK-Lambda Americas Inc. Fully insert the connector end of the HV cable and tighten the locking nut only “hand tight”.

NOTE: When operating above 20kV and/or 200 Hz rep. rate, ensure that silicone grease (such as Dow Corning DC-4) is applied to the HV cable before insertion into the HV connector. This displaces the air in the connector and reduces long term corona damage.

Keep the HV cable bend radius greater than 4 inches (102mm) to minimize stress on the insulation. Keep the HV cable as distant as possible from the input power and the input control signals.

Some peak current will flow out of the power supply during discharge and return through the HV return and system chassis. This current comes from voltage reversal in under damped systems and from normal discharge of filter and cable capacitance. The path for this current should not parallel control signal returns since the resulting voltages could interfere with normal system operation. The currents developed with voltage reversal at high rep. rates, could damage the power supply. A resistor in series with the HV output can be added to limit this current to an acceptable level. Refer to Section 5.2, Page 16 or the TDK-Lambda High Power online application notes for more information.

The oil-filled HV assembly should not be opened. The oil and components have been specially cleaned and vacuum impregnated at the factory and the assembly hermetically sealed. Opening the assembly will compromise performance and void the warranty. Tanks must only be serviced at TDK-Lambda Americas Inc.

3.6 GROUNDING THE PRODUCT

3.6.1 GROUNDING OF INPUT LINE

The supply is grounded through the ground terminal of the input connector. A protective ground connection by the way of the grounding conductor in the input terminal is essential for safe operation.

3.6.2 OUTPUT GROUND CONNECTION

It is important that there be a ground connecting the supply to the load as shown in Figure 3-3.

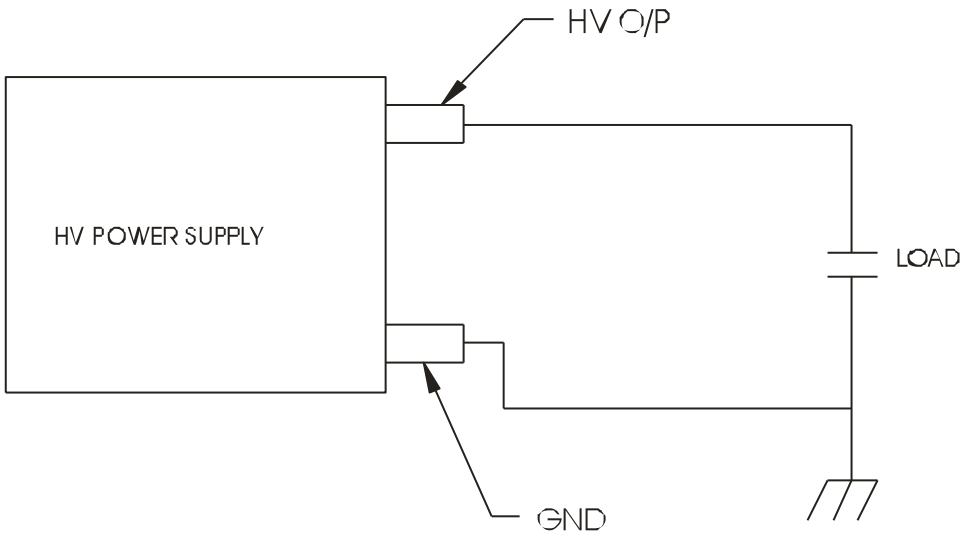


Figure 3-3 Output Ground Connection

3.6.3 FOR UNITS WITH O/P VOLTAGE ≤ 6kV

The ground connection is made via the shield of the RG59 coaxial HV output cable provided with the supply.

3.6.4 FOR UNITS WITH O/P VOLTAGE > 6kV:

The ground connection between the load and the supply must be made with a separate wire to the 8-32 UNC, ½ “long grounding stud provided on the supply.

CHAPTER 4 OPERATION

4.1 REMOTE CONTROL

The Series 500A/102A/152A/202A is easily controlled through the remote connector on the input panel of the unit. Only the ENABLE/RESET, V PROGRAM and GND signals are required for operation. The remaining signals are provided for status monitoring and fault diagnosis. A schematic diagram showing the suggested interface circuit is shown in Figure 4-1. This table is for a standard configuration.

PIN	SIGNAL NAME	I/O	DESCRIPTION
1	ENABLE/RESET	INPUT	A high signal (+10 to 15V) with respect to ground (pin 14) will enable the power supply. Latching faults can be cleared by cycling this switch. Ground or open disables the supply.
5	VPROGRAM	INPUT	A 0-10V signal with respect to ground at this pin programs the output voltage proportionally from zero to rated output. For a “-5V” option the unit VPROGRAM is 0-5V.
7	VPEAK	OUTPUT	A 0-10V signal with respect to ground proportional to the peak of the output charging voltage. Can be used to drive a meter displaying peak output voltage. For a “-5V” option the value for VPEAK is 0-5.5V.
8	VANALOG	OUTPUT	0-10V analog of output charging voltage waveform. For a “-5V” option the value for VANALOG is 0-5.5V (remote pin 8).
10	INHIBIT	INPUT	A +10 TO 15V with respect to ground, disables the unit. Open or ground allows operation. This input can be used to disable charging during HV switch recovery.
9, 11	+15V	OUTPUT	15V regulated. Can be used or user programming applications 20mA max.
14	GND	OUTPUT	Control circuit return. Also chassis/earth ground
15	INHIBIT LED	OUTPUT	INHIBIT LED displays the logical OR of all the internal and external signals that prevent HV output current, including EOC, EXTERNAL INHIBIT, OVERLOAD, and any fault.
13	EOC LED	OUTPUT	Open collector. Indicates that the power supply is reaching end-of-charge, i.e. the V PROGRAM set point.
3, 6	SUMMARY FAULT LED	OUTPUT	Open collector. Indicates an output overvoltage. Temperature fault or low input voltage condition.
2	LOAD FAULT	OUTPUT	Indicates a shorted O/P or a very large load capacitor.

Table 4-1 Control Interface Connection for Standard 500A/102A/152A/202A Series

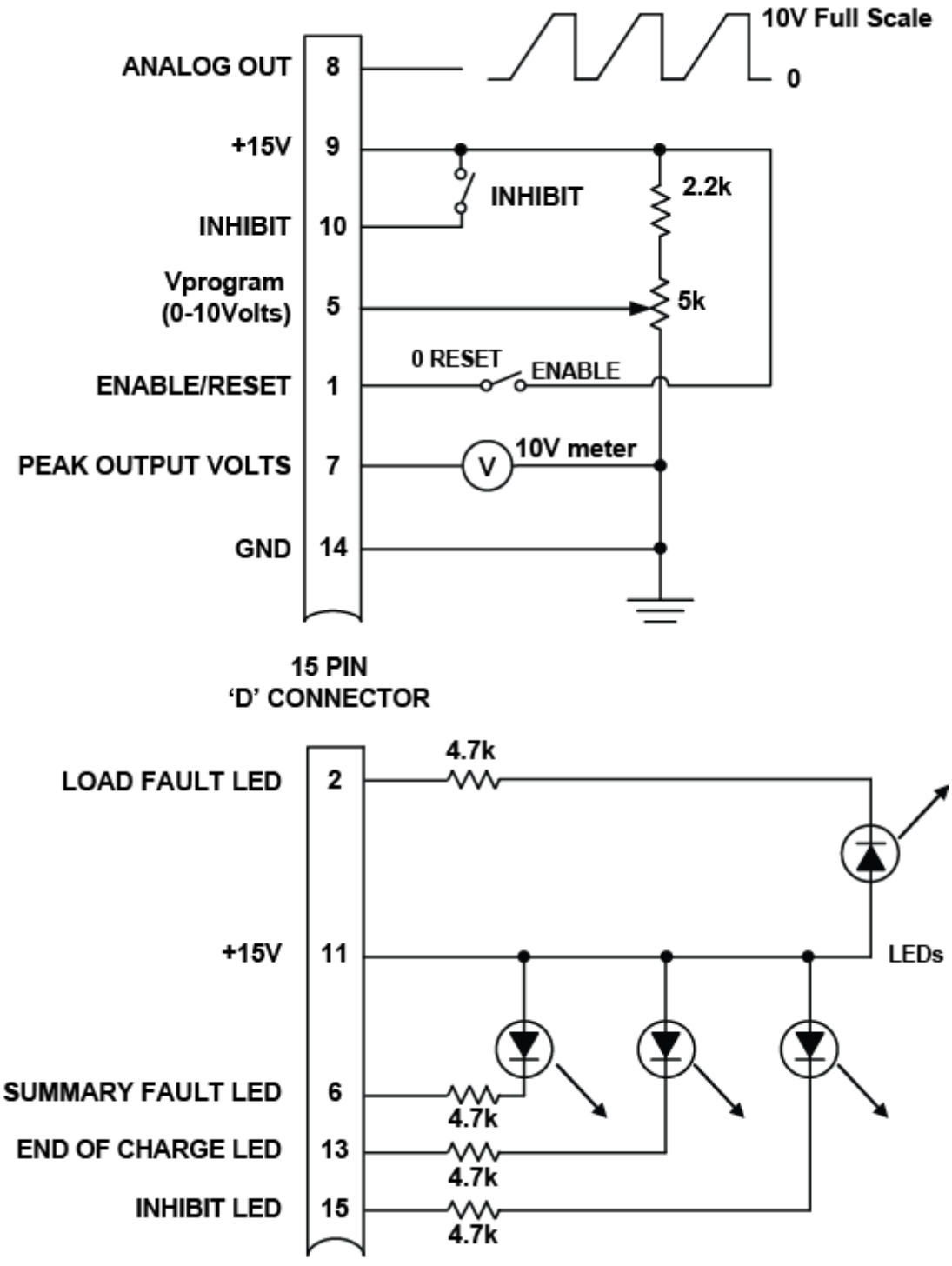
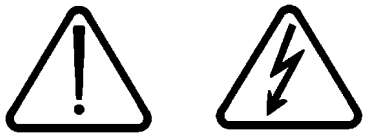


Figure 4-1 Example of Interface Connection

4.2 OUT-OF-BOX-INSPECTION



LETHAL VOLTAGES PRESENT

4.2.1 VISUAL INSPECTION

Prior to shipment, this instrument was inspected and found to be free of mechanical and electrical defects. As soon as the unit is unpacked, inspect for any damage that may have occurred in transit. Verify the following:

A. Confirm that there are no dents or scratches on the panel surfaces.

If any damage is found, follow the instructions in the "Returning Equipment" instructions section of this manual.

4.2.2 ELECTRICAL INSPECTION

Before the power supply is installed in a system, verify that no internal damage occurred during shipping. A simple preliminary electrical test should be performed. This test is described below.

4.2.2.1 TEST 1

Purpose: Verify general overload operation.

1. With AC power "OFF" and disconnected, short the H.V. output by connecting the center conductor of the output cable to its return shield (or ground). This dead short forces the unit to generate full output current at zero voltage.
2. Set the output voltage control to zero. Connect the AC power to the unit. Turn the AC power "ON".
3. Turn the H.V. on and turn up the H.V. control until the power supply is generating output current into the dead short. The power supply will intermittently turn on and off indicating the "overload" condition. The unit should continue to cycle in this mode with a 1 sec. repetition rate indefinitely (500mS on and 500mS off). The power supply will go into overload when max. Current is drawn for more than half a second.
4. Turn off the H.V. and A.C. power.

This test indicates the inverter section is generating maximum current and the logic and overload circuitry works correctly.

4.2.2.2 TEST 2

Purpose: Verify that the power supply generates maximum rated voltage, and the regulation and feedback circuits are functioning.

1. With AC power OFF and disconnected, connect an appropriate load capacitor to the power supply output cable.
2. Prepare to charge the capacitor. NOTE: Operating a 502A/102A/152A/202A power supply into an open circuit (no load operation) will instantly damage the power supply's H.V. output diodes. Make sure the load (capacitor) is connected and the H.V. output cable is securely inserted and connected.
3. Turn the voltage control all the way down to zero, apply AC power and turn the HV ON. By turning up the H.V. control knob the capacitor will charge to the programmed voltage The power supply may be turned all the way up to its maximum output voltage provided the load capacitor is sufficiently rated.

4. By turning the voltage control down or turning the H.V. OFF, the capacitor will "bleed" down through the internal voltage divider resistors used for regulation feedback.

NOTE: An overload condition can occur if the INHIBIT signal is missing, allowing HV switch to latch-up. It can also occur if the discharge rep. rate is too high to allow the capacitor to fully charge to V PROGRAM.

Test #2 indicates the H.V. section is working correctly. Tests 1 and 2 generally indicate the unit is functioning as designed. Although 100% power had not been generated, these two tests give greater than 90% confidence that the unit is not damaged.
If any inconsistency from the above test procedure is noted, do not hesitate to call Lambda Americas Customer Service for assistance. If equipped with an oil-filled tank this assembly should not be opened unless. This oil filled tank has been hermetically sealed at the factory. Opening the supply or the assembly will void the factory warranty, and may compromise performance.

4.3 CONTACTING TDK-LAMBDA AMERICAS CUSTOMER SERVICE

When contacting customer service locate the product description, part number and serial number from the label located on the rear of the unit, and have this information available.

Phone: (732) 795-4100 E-mail: hp.service@us.tdk-lambda.com
Fax: (732) 922-9334

Customer Service, or an approved Service Center, should be contacted if:

- The power supply is mechanically or electrically damaged.
- The power supply requires on-site calibration, or replacement warning decals.
- The customer has questions about a special application that is not described in this manual.

Normally, the customer may *NOT* open any chassis covers that have a warranty seal. Breaking a seal will void the warranty.

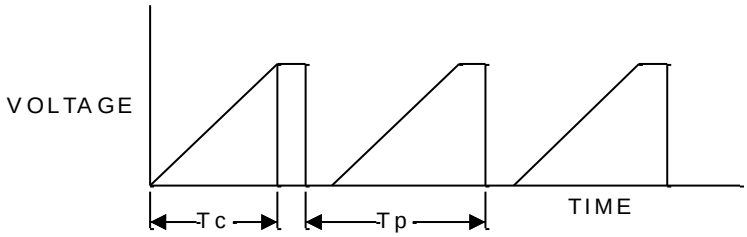
At the discretion of TDK-Lambda Americas, the customer may be granted permission to break the warranty seal and open the chassis covers. Customer Service shall confirm the permission by sending a replacement seal. Once the unit has been serviced, the customer shall close the cover and apply the replacement seal adjacent to (not on top of) the broken seal.

CHAPTER 5 APPLICATIONS

For clarification and further technical assistance specific to your applications, please contact TDK-Lambda Americas Inc.

5.1 DETERMINING CAPACITOR CHARGE TIME

The ratings of these supplies are as follows: 500A – 500 J/s, 102A – 1000 J/s, 152A – 1500J/s, 202A-2000J/s average charge rate. Although the measure of Joules/sec equates to Watts, Stored Energy per unit time is more convenient when working with energy storage capacitors. The peak charge rate determines the capacitor charge time. The average charge rate determines the total power delivered from the power supply. It is possible to charge a capacitor at 1650 J/sec, but to discharge it at a low rep. rate producing an average of 100 J/sec. The following formulas can be used to determine the average and peak charge rate.



Peak Charge Rate = $\frac{\frac{1}{2}CV^2}{T_C}$

Average Charge Rate = $\frac{\frac{1}{2}CV^2}{T_p}$

C - OUTPUT LOAD CAPACITOR

V - PROGRAMMED OUTPUT VOLTAGE

T_C and T_P are shown in figure

Figure 5-1 Output Voltage Waveform

5.2 VOLTAGE REVERSAL

When the capacitor or PFN is discharged, a high peak current may flow out of the power supply as a result of voltage reversal. This occurs in a system which is under damped in order to clear the high voltage switch after each pulse. The average value of this peak current added to the normal output current may exceed the rating of the HV diodes in the power supply. This current can be measured with a current transformer as shown in Figure 5.2.

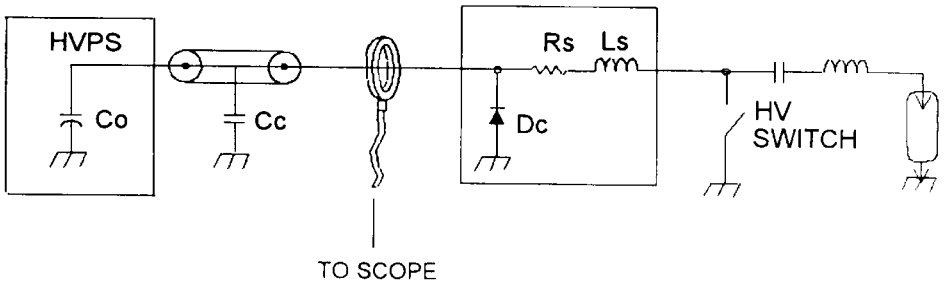


Figure 5-2 Output Current Measurement

A series terminating resistor (or series inductor or clamp diode) must be added as shown if the average value of the peak current exceeds 110% of the normal output current.

When choosing Rs, ensure it can withstand the full output voltage across it as well as the power dissipation caused by discharging Co (see Table 5.1) and Cc (20pF/ft) (65.62 pf/m) each cycle as well as conducting the normal output current. It's power dissipation can be calculated as $Pd = (Io^2\ Rs) + ½\ (Co + Cc)\ V^2\ (REP\ RATE)$.

Output Voltage	Co
1-2.8kV	60nF
3kV-6kV	15nF
10-30kV	460pF
40kV	230pF

Table 5-1 Output Capacitance

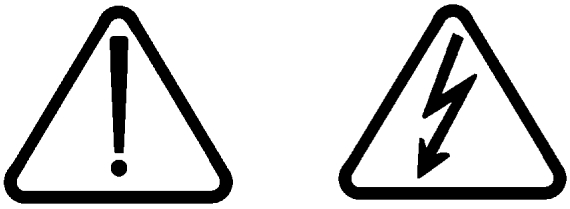
5.3 PARALLELING UNITS

The 500A/102A/152A/202A power supplies are designed for simple parallel operation. The input power and HV output should be connected directly together. The REMOTE connectors on the input panel can also be connected directly together using a "daisy chain" ribbon cable from the system controller. Each of the power supplies operate at the same time with the total charge rate equal to the sum of each.

Sometimes when operating several units in parallel, the high total power generates noise which interferes with the power supply control. This is usually due to the many interconnecting control cables acting as an antenna picking up noise. The problem usually appears as one or more of the power supplies shuts down when the output voltage increases beyond a certain level. Dressing the control cables as short as possible and close to ground or using shielded cables should help. In severe cases, it is necessary to wrap the cables several times through high permeability ferrite cores at the input panel of each unit.

The 500A/102A/152A/202A power supplies can also be used as an Isolated High Voltage continuous DC power source by adding an external filter capacitor. The value of the filter capacitor depends upon the value of the allowable output voltage ripple value. For parallel operation into DC loads, please contact TDK-Lambda Americas Inc. Customer Service Department. (See Section 5.6).

5.4 MEASURING HIGH VOLTAGES



WARNING: EXTREME CAUTION MUST ALWAYS BE EXERCISED WHEN TAKING ANY HIGH VOLTAGE MEASUREMENTS. IT SHOULD BE DONE ONLY BY QUALIFIED PERSONNEL WHO ARE TRAINED IN THE SAFETY ASPECTS OF WORKING WITH HIGH VOLTAGE.

A sample of the output voltage is available at the REMOTE connector. If it is desired to measure the HV output externally, care must be taken to understand the accuracy of the measurement.

When making a DC measurement, such as when the power supply is holding voltage on a capacitor, any HV probe and DVM combination can be used. The Fluke 80K-40 probe with any 10M input resistance DVM is adequate up to 40kV. Building a simple resistor divider using appropriate HV resistors is also very straightforward. Keep in mind that all HV resistors, including the one in the Fluke probe, exhibit a negative voltage coefficient, changing by up to 4% from zero to max. voltage. De-rating the resistors and calibrating at the operating point solves this problem.

The value of the resistor R1 and R2 (Figure 5.3) can be calculated as follows:

$$V_M = \frac{R_2}{R_1 + R_2} \times Vo$$

where Vo is the High Voltage being measured.

Making a pulsed measurement with an oscilloscope requires a compensated HV probe having a wide bandwidth. Simply connecting a DC probe, through the proper resistance, into a scope yields a slow response only adequate for low rep. rate systems. As with DC probes, the pulsed probe resistor voltage coefficient is a problem. In addition, damage to the resistors can occur during pulsing due to high electric field gradients. Also, stray capacitance to nearby objects can significantly alter the pulse response. For a high-performance, shielded probe to 40KV use a Tektronix P6015 or Ross Engineering VD60-8.3-A-K-LB.

Measurements accurate to better than 0.1% can be achieved using a bias technique. For example, if a 40V signal (40kV divided by 1000) is to be measured accurately, the minus input of the DVM would be biased up 40V. The original signal, with respect to ground, is fed to the plus input of the DVM. The bias can be measured accurately for absolute measurements, or relative measurements read directly as the line or load is varied. In the same manner, an oscilloscope return can be biased for accurate peak measurements during pulsing.

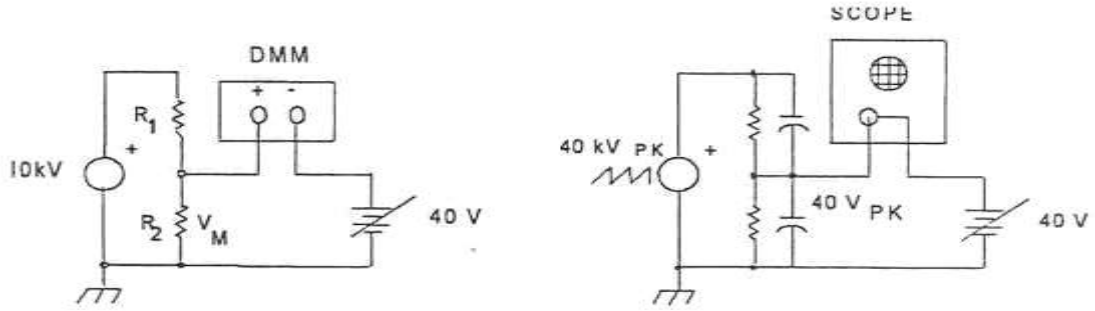


Figure 5-3 HV Bias Measurements

5.5 DETERMINING AC LINE CURRENT

$$I_L = \frac{P}{V_L P_F \times EFF}$$

IL = Line current

P = Average output power

VL = Line voltage

PF = Power factor (.65 min)

EFF = 0.85

Ex: A 152A operating from 115V – 10% and delivering 1000W average.

$$I_L = \frac{1000}{(115)(.65)(0.85)} x\,0.9 = 17.5A$$

When charging very large capacitor banks requiring many seconds or minutes to reach end-of-charge, the power supply will display a load fault and go into a 50% duty cycle protection mode. If this feature is defeated and the power supply is allowed to charge for an extended period, the peak output power, not the average power, must be used to determine line current. (See Section 5.7).

5.6 CONTINUOUS HV DC OPERATION (CONSTANT VOLTAGE)

The 500A/102A/152A/202A supplies can be used as a constant voltage supply by the addition of an external filter capacitor. The value of this capacitor will determine the ripple voltage on the DC output.

$$\Delta V_{PK-PK} = \frac{1.4(Po\max)}{Vo)(Co)(Fs)}$$

Where: Po max = Maximum output power in watts

Vo = Output voltage in volts

Co = Total output capacitance in microfarads

Fs = Lowest switching frequency (40KHz)

When operating as a DC supply care must be taken not to draw more than the J/sec rating of the unit.

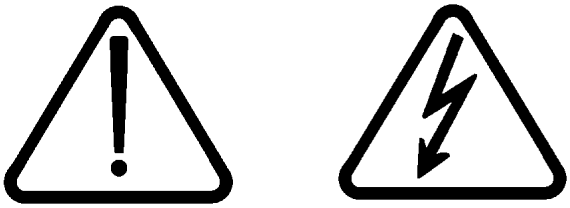
Also, if the filter capacitor is inadvertently shorted, it may ring which can damage the supply (Section 5.2).

5.7 LONG CHARGE TIME WITH POWER FACTOR CORRECTED (PFC) UNITS

It is advised that you consult the factory if this type of operation is required.

A special long charge programming adaptor is available for applications with charge times greater than 500 milliseconds. Visit the TDK-Lambda High Power website or contact customer service for details.

CHAPTER 6 MAINTENANCE AND CALIBRATION



6.1 SAFETY PRECAUTIONS

ONLY QUALIFIED PERSONNEL TRAINED IN THE SAFETY ASPECTS OF HIGH VOLTAGE SHOULD PERFORM CALIBRATION.

The calibration steps described in this section require operation of the power supply with the cover removed. Proceed with extreme caution as hazardous voltages are exposed throughout the unit.

Safety glasses must be worn to prevent serious injury in the event of a component failure (e.g., power transistors readily explode during fault conditions).

Because the power supply does not receive proper cooling with the cover removed, it must be cooled by an external fan placed next to the supply to cool the inverter and HV section (min. air flow 100 CFM (2.83 M3/min.)) when operating at full power. Operation at full power with cover removed should be limited to less than five minutes.

6.2 MAINTENANCE

No maintenance is required under normal operating conditions. Occasional vacuum or blow-out of the chassis may be required when operated in extremely dirty environments. The oil-filled HV assembly must not be opened. The oil and components have been specially cleaned and vacuum impregnated at the factory and the assembly hermetically sealed. Opening assembly will compromise performance and void warranty. HV Tanks must only be services at TDK-Lambda Americas Inc.

6.3 CALIBRATION

Calibration of the output voltage is accomplished with trim pot RP4 located on the control board. This is the top PC board of the inverter assembly. RP4 is a 25 turn trim pot. Slowly turn it clockwise to decrease the output voltage for a given VPROGRAM. Factory set for 10V rated voltage for standard version. Refer to Sections 2.4.1 and 2.4.2 of product specification for Linearity and Accuracy.

SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: **UNIVOLT N 61 B**
Product Description: Base Oil and Additives
Product Code: 201580102520, 730846-00, 97P847
Intended Use: Electrical insulating oils

COMPANY IDENTIFICATION

Supplier: **EXXON MOBIL CORPORATION**
22777 Springwoods Village Parkway
Spring, TX. 77389 USA

24 Hour Health Emergency	609-737-4411
Transportation Emergency Phone	800-424-9300 or 703-527-3887 CHEMTREC
Product Technical Information	800-662-4525
MSDS Internet Address	http://www.exxon.com, http://www.mobil.com

SECTION 2 HAZARDS IDENTIFICATION

This material is hazardous according to regulatory guidelines (see (M)SDS Section 15).

CLASSIFICATION:

Aspiration toxicant: Category 1.

LABEL:
Pictogram:

Signal Word: Danger

Hazard Statements:
H304: May be fatal if swallowed and enters airways.

Precautionary Statements:
P273: Avoid release to the environment.P301 + P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. P331: Do NOT induce vomiting. P391: Collect spillage.P405: Store locked up.P501: Dispose of contents and container in accordance with local regulations.

Other hazard information:

HAZARD NOT OTHERWISE CLASSIFIED (HNOC): None as defined under 29 CFR 1910.1200.

PHYSICAL / CHEMICAL HAZARDS

No significant hazards.

HEALTH HAZARDS

Frequent or prolonged contact may defat and dry the skin, leading to discomfort and dermatitis. May be irritating to the eyes, nose, throat, and lungs.

ENVIRONMENTAL HAZARDS

Expected to be toxic to aquatic organisms. May cause long-term adverse effects in the aquatic environment.

NFPA Hazard ID:	Health:	1	Flammability:	1	Reactivity:	0
HMIS Hazard ID:	Health:	1*	Flammability:	1	Reactivity:	0

NOTE: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

This material is defined as a mixture.

Hazardous Substance(s) or Complex Substance(s) required for disclosure

Name	CAS#	Concentration*	GHS Hazard Codes
2,6-DI-TERT-BUTYL-P-CRESOL	128-37-0	1 - < 5%	H400(M factor 1), H410(M factor 1)
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	64742-53-6	90 - < 100%	H304

* All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

As per paragraph (i) of 29 CFR 1910.1200, formulation is considered a trade secret and specific chemical identity and exact percentage (concentration) of composition may have been withheld. Specific chemical identity and exact percentage composition will be provided to health professionals, employees, or designated representatives in accordance with applicable provisions of paragraph (i).

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. Remove contaminated clothing. Launder contaminated clothing before reuse.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

Seek immediate medical attention. Do not induce vomiting.

NOTE TO PHYSICIAN

If ingested, material may be aspirated into the lungs and cause chemical pneumonitis. Treat appropriately.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO2) to extinguish flames.

Inappropriate Extinguishing Media: Straight Streams of Water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply. Firefighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Hazardous Combustion Products: Aldehydes, Oxides of carbon, Sulfur oxides, Smoke, Fume, Incomplete combustion products

FLAMMABILITY PROPERTIES

Flash Point [Method]: >145°C (293°F) [ASTM D-92]
Flammable Limits (Approximate volume % in air): LEL: N/D UEL: N/D
Autoignition Temperature: >315°C (599°F)

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations. US regulations require reporting releases of this material to the environment which exceed the applicable reportable quantity or oil spills which could reach any waterway including intermittent dry creeks. The National Response Center can be reached at (800)424-8802.

PROTECTIVE MEASURES

Avoid contact with spilled material. Warn or evacuate occupants in surrounding and downwind areas if required due to toxicity or flammability of the material. See Section 5 for fire fighting information. See the Hazard Identification Section for Significant Hazards. See Section 4 for First Aid Advice. See Section 8 for advice on the minimum requirements for personal protective equipment. Additional protective measures may be necessary, depending on the specific circumstances and/or the expert judgment of the emergency responders.

For emergency responders: Respiratory protection: respiratory protection will be necessary only in special cases, e.g., formation of mists. Half-face or full-face respirator with filter(s) for dust/organic vapor or Self Contained Breathing Apparatus (SCBA) can be used depending on the size of spill and potential level of

exposure. If the exposure cannot be completely characterized or an oxygen deficient atmosphere is possible or anticipated, SCBA is recommended. Work gloves that are resistant to hydrocarbons are recommended. Gloves made of polyvinyl acetate (PVA) are not water-resistant and are not suitable for emergency use. Chemical goggles are recommended if splashes or contact with eyes is possible. Small spills: normal antistatic work clothes are usually adequate. Large spills: full body suit of chemical resistant, antistatic material is recommended.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do it without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do it without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dike far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7 HANDLING AND STORAGE

HANDLING

Avoid contact with skin. Prevent small spills and leakage to avoid slip hazard. Material can accumulate static charges which may cause an electrical spark (ignition source). When the material is handled in bulk, an electrical spark could ignite any flammable vapors from liquids or residues that may be present (e.g., during switch-loading operations). Use proper bonding and/or ground procedures. However, bonding and grounds may not eliminate the hazard from static accumulation. Consult local applicable standards for guidance. Additional references include American Petroleum Institute 2003 (Protection Against Ignitions Arising out of Static, Lightning and Stray Currents) or National Fire Protection Agency 77 (Recommended Practice on Static Electricity) or CENELEC CLC/TR 50404 (Electrostatics - Code of practice for the avoidance of hazards due to static electricity).

Static Accumulator: This material is a static accumulator.

STORAGE

The container choice, for example storage vessel, may effect static accumulation and dissipation. Do not store in open or unlabelled containers.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMIT VALUES

Exposure limits/standards (Note: Exposure limits are not additive)

Substance Name	Form	Limit / Standard			NOTE	Source
2,6-DI-TERT-BUTYL-P-CRESOL	Inhalable fraction and	TWA	2 mg/m3		N/A	ACGIH

	vapor					
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	Mist.	TWA	5 mg/m3		N/A	OSHA Z1
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	Inhalable fraction.	TWA	5 mg/m3		N/A	ACGIH
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	Mist.	TWA	5 mg/m3		N/A	ACGIH

Exposure limits/standards for materials that can be formed when handling this product: When mists/aerosols can occur the following are recommended: 5 mg/m³ - ACGIH TLV (inhalable fraction), 5 mg/m³ - OSHA PEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

No biological limits allocated.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapor warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. Inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

If prolonged or repeated contact is likely, chemical resistant gloves are recommended. If contact with forearms is likely, wear gauntlet style gloves.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

If prolonged or repeated contact is likely, chemical, and oil resistant clothing is recommended.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practice good housekeeping.

ENVIRONMENTAL CONTROLS

Comply with applicable environmental regulations limiting discharge to air, water and soil. Protect the environment by applying appropriate control measures to prevent or limit emissions.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Note: Physical and chemical properties are provided for safety, health and environmental considerations only and may not fully represent product specifications. Contact the Supplier for additional information.

GENERAL INFORMATION

Physical State: Liquid
Color: Pale Yellow
Odor: Characteristic
Odor Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 °C): 0.883
Flammability (Solid, Gas): N/A
Flash Point [Method]: >145°C (293°F) [ASTM D-92]
Flammable Limits (Approximate volume % in air): LEL: N/D UEL: N/D
Autoignition Temperature: >315°C (599°F)
Boiling Point / Range: N/A
Decomposition Temperature: N/D
Vapor Density (Air = 1): > 5 at 101 kPa [Estimated]
Vapor Pressure: < 0.013 kPa (0.1 mm Hg) at 20 °C [Estimated]
Evaporation Rate (n-butyl acetate = 1): N/D
pH: N/A
Log Pow (n-Octanol/Water Partition Coefficient): > 6.5 [Estimated]
Solubility in Water: Negligible
Viscosity: 8.18 cSt (8.18 mm2/sec) at 40 °C | 2.18 cSt (2.18 mm2/sec) at 100°C
Oxidizing Properties: See Hazards Identification Section.

OTHER INFORMATION

Freezing Point: N/D
Melting Point: -55°C (-67°F)
Pour Point: -40°C (-40°F)
DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10 STABILITY AND REACTIVITY

REACTIVITY: See sub-sections below.

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

POSSIBILITY OF HAZARDOUS REACTIONS: Hazardous polymerization will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

INFORMATION ON TOXICOLOGICAL EFFECTS

Hazard Class	Conclusion / Remarks
Inhalation	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Irritation: No end point data for material.	Elevated temperatures or mechanical action may form vapors, mist, or fumes which may be irritating to the eyes, nose, throat, or lungs.
Ingestion	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Skin	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Skin Corrosion/Irritation: No end point data for material.	May dry the skin leading to discomfort and dermatitis. Based on assessment of the components.
Eye	
Serious Eye Damage/Irritation: No end point data for material.	May cause mild, short-lasting discomfort to eyes. Based on assessment of the components.
Sensitization	
Respiratory Sensitization: No end point data for material.	Not expected to be a respiratory sensitizer.
Skin Sensitization: No end point data for material.	Not expected to be a skin sensitizer. Based on assessment of the components.
Aspiration: Data available.	May be fatal if swallowed and enters airways. Based on physico-chemical properties of the material.
Germ Cell Mutagenicity: No end point data for material.	Not expected to be a germ cell mutagen. Based on assessment of the components.
Carcinogenicity: No end point data for material.	Not expected to cause cancer. Based on assessment of the components.
Reproductive Toxicity: No end point data for material.	Not expected to be a reproductive toxicant. Based on assessment of the components.
Lactation: No end point data for material.	Not expected to cause harm to breast-fed children.
Specific Target Organ Toxicity (STOT)	
Single Exposure: No end point data for material.	Not expected to cause organ damage from a single exposure.
Repeated Exposure: No end point data for material.	Not expected to cause organ damage from prolonged or repeated exposure. Based on assessment of the components.

TOXICITY FOR SUBSTANCES

NAME	ACUTE TOXICITY
2,6-DI-TERT-BUTYL-P-CRESOL	Oral Lethality: LD50 0.89 g/kg (Rat)

OTHER INFORMATION

For the product itself:

Prolonged and/or repeated skin contact with low viscosity materials may defat the skin resulting in possible irritation and dermatitis.
Small amounts of liquid aspirated into the lungs during ingestion or from vomiting may cause chemical pneumonitis or pulmonary edema.

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitizing in test animals.

The following ingredients are cited on the lists below: None.

--REGULATORY LISTS SEARCHED--

1 = NTP CARC	3 = IARC 1	5 = IARC 2B
2 = NTP SUS	4 = IARC 2A	6 = OSHA CARC

SECTION 12 ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Expected to be toxic to aquatic organisms. May cause long-term adverse effects in the aquatic environment.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products. Protect the environment. Dispose of used oil at designated sites. Minimize skin contact. Do not mix used oils with solvents, brake fluids or coolants.

REGULATORY DISPOSAL INFORMATION

RCRA Information: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed as hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity or reactivity and is not formulated with contaminants as determined by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14 TRANSPORT INFORMATION

LAND (DOT): Not Regulated for Land Transport

LAND (TDG): Not Regulated for Land Transport

SEA (IMDG): Not Regulated for Sea Transport according to IMDG-Code

Marine Pollutant: No

AIR (IATA): Not Regulated for Air Transport

SECTION 15 REGULATORY INFORMATION

OSHA HAZARD COMMUNICATION STANDARD: This material is considered hazardous in accordance with OSHA HazCom 2012, 29 CFR 1910.1200.

Listed or exempt from listing/notification on the following chemical inventories: AICS, DSL, ENCS, IECSC, KECI, PICCS, TSCA

EPCRA SECTION 302: This material contains no extremely hazardous substances.

SARA (311/312) REPORTABLE HAZARD CATEGORIES: Immediate Health. Delayed Health.

SARA (313) TOXIC RELEASE INVENTORY: This material contains no chemicals subject to the supplier notification requirements of the SARA 313 Toxic Release Program.

The following ingredients are cited on the lists below:

Chemical Name	CAS Number	List Citations
2,6-DI-TERT-BUTYL-P-CRESOL	128-37-0	1, 13, 16, 17, 18
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	64742-53-6	1, 4, 13, 17, 18

--REGULATORY LISTS SEARCHED--

1 = ACGIH ALL	6 = TSCA 5a2	11 = CA P65 REPRO	16 = MN RTK
2 = ACGIH A1	7 = TSCA 5e	12 = CA RTK	17 = NJ RTK
3 = ACGIH A2	8 = TSCA 6	13 = IL RTK	18 = PA RTK
4 = OSHA Z	9 = TSCA 12b	14 = LA RTK	19 = RI RTK
5 = TSCA 4	10 = CA P65 CARC	15 = MI 293	

Code key: CARC=Carcinogen; REPRO=Reproductive

SECTION 16 OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

KEY TO THE H-CODES CONTAINED IN SECTION 3 OF THIS DOCUMENT (for information only):
H304: May be fatal if swallowed and enters airways; Aspiration, Cat 1
H400: Very toxic to aquatic life; Acute Env Tox, Cat 1
H410: Very toxic to aquatic life with long lasting effects; Chronic Env Tox, Cat 1

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:
Updates made in accordance with implementation of GHS requirements.

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Internal Use Only

MHC: 2A, 0B, 0, 0, 1, 1 PPEC: C

DGN: 2011629XUS (548632)

SAFETY DATA SHEET

According to OSHA Hazard Communication Standard, 29 CFR 1910.1200

Shell Diala S2 ZX-A

Version	Revision Date:	SDS Number:	Print Date: 04/03/2020
3.2	04/02/2020	800001009714	Date of last issue: 12/06/2018

SECTION 1. IDENTIFICATION

Product name : Shell Diala S2 ZX-A

Product code : 001D8374

Manufacturer or supplier's details

Manufacturer/Supplier : **Shell Oil Products US**
PO Box 4427
Houston TX 77210-4427
USA

SDS Request : (+1) 877-276-7285

Customer Service :

Emergency telephone number

Spill Information : 877-504-9351

Health Information : 877-242-7400

Recommended use of the chemical and restrictions on use

Recommended use : Insulating oil.

SECTION 2. HAZARDS IDENTIFICATION

GHS classification in accordance with 29 CFR 1910.1200

Aspiration hazard : Category 1

Long-term (chronic) aquatic hazard : Category 3

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : PHYSICAL HAZARDS:
Not classified as a physical hazard under GHS criteria.
HEALTH HAZARDS:
H304 May be fatal if swallowed and enters airways.
ENVIRONMENTAL HAZARDS:
H412 Harmful to aquatic life with long lasting effects.

Precautionary statements : **Prevention:**
P273 Avoid release to the environment.

Response:

P301 + P310 IF SWALLOWED: Immediately call a POISON CENTER/doctor.
P331 Do NOT induce vomiting.

Storage:

P405 Store locked up.

Disposal:

P501 Dispose of contents/ container to an approved waste disposal plant.

Hazardous components which must be listed on the label:
Contains Distillates (petroleum), hydrotreated light naphthenic.

Other hazards which do not result in classification

Prolonged or repeated skin contact without proper cleaning can clog the pores of the skin resulting in disorders such as oil acne/folliculitis.
Used oil may contain harmful impurities.
Not classified as flammable but will burn.
The classification of this material is based on OSHA HCS 2012 criteria.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical nature : Highly refined mineral oils and additives.
The highly refined mineral oil contains <3% (w/w) DMSO-extract, according to IP346.

Hazardous components

Chemical name	Synonyms	CAS-No.	Concentration (% w/w)
Distillates (petroleum), hydrotreated light naphthenic	Distillates (petroleum), hydrotreated light naphthenic	64742-53-6	95 - 100
Butylated hydroxytoluene	2,6-di-tert-butyl-p-cresol	128-37-0	0.25 - 0.5

SECTION 4. FIRST-AID MEASURES

If inhaled : No treatment necessary under normal conditions of use.
If symptoms persist, obtain medical advice.

In case of skin contact : Remove contaminated clothing. Flush exposed area with water and follow by washing with soap if available.
If persistent irritation occurs, obtain medical attention.

In case of eye contact : Flush eye with copious quantities of water.
Remove contact lenses, if present and easy to do. Continue rinsing.
If persistent irritation occurs, obtain medical attention.

If swallowed : Call emergency number for your location / facility.
If swallowed, do not induce vomiting: transport to nearest

		medical facility for additional treatment. If vomiting occurs spontaneously, keep head below hips to prevent aspiration. If any of the following delayed signs and symptoms appear within the next 6 hours, transport to the nearest medical facility: fever greater than 101° F (38.3°C), shortness of breath, chest congestion or continued coughing or wheezing.
Most important symptoms and effects, both acute and delayed	:	If material enters lungs, signs and symptoms may include coughing, choking, wheezing, difficulty in breathing, chest congestion, shortness of breath, and/or fever. The onset of respiratory symptoms may be delayed for several hours after exposure. Defatting dermatitis signs and symptoms may include a burning sensation and/or a dried/cracked appearance. Ingestion may result in nausea, vomiting and/or diarrhoea.
Protection of first-aiders	:	When administering first aid, ensure that you are wearing the appropriate personal protective equipment according to the incident, injury and surroundings.
Indication of any immediate medical attention and special treatment needed	:	Potential for chemical pneumonitis. Call a doctor or poison control center for guidance.

SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	Foam, water spray or fog. Dry chemical powder, carbon dioxide, sand or earth may be used for small fires only.
Unsuitable extinguishing media	:	Do not use water in a jet.
Specific hazards during fire-fighting	:	Hazardous combustion products may include: A complex mixture of airborne solid and liquid particulates and gases (smoke). Carbon monoxide may be evolved if incomplete combustion occurs. Unidentified organic and inorganic compounds.
Specific extinguishing methods	:	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Special protective equipment for firefighters	:	Proper protective equipment including chemical resistant gloves are to be worn; chemical resistant suit is indicated if large contact with spilled product is expected. Self-Contained Breathing Apparatus must be worn when approaching a fire in a confined space. Select fire fighter's clothing approved to relevant Standards (e.g. Europe: EN469).

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protec-	:	Avoid contact with skin and eyes.

tive equipment and emergency procedures

Environmental precautions	:	Local authorities should be advised if significant spillages cannot be contained.
Methods and materials for containment and cleaning up	:	Slippery when spilt. Avoid accidents, clean up immediately. Prevent from spreading by making a barrier with sand, earth or other containment material. Reclaim liquid directly or in an absorbent. Soak up residue with an absorbent such as clay, sand or other suitable material and dispose of properly.
Additional advice	:	For guidance on selection of personal protective equipment see Chapter 8 of this Safety Data Sheet. For guidance on disposal of spilled material see Chapter 13 of this Safety Data Sheet.

SECTION 7. HANDLING AND STORAGE

Technical measures	:	Use local exhaust ventilation if there is risk of inhalation of vapours, mists or aerosols. Use the information in this data sheet as input to a risk assessment of local circumstances to help determine appropriate controls for safe handling, storage and disposal of this material.
Advice on safe handling	:	Avoid prolonged or repeated contact with skin. Avoid inhaling vapour and/or mists. When handling product in drums, safety footwear should be worn and proper handling equipment should be used. Properly dispose of any contaminated rags or cleaning materials in order to prevent fires.
Avoidance of contact	:	Strong oxidising agents.
Product Transfer	:	Proper grounding and bonding procedures should be used during all bulk transfer operations to avoid static accumulation.
Further information on storage stability	:	Keep container tightly closed and in a cool, well-ventilated place. Use properly labeled and closable containers. Store at ambient temperature.
Packaging material	:	Suitable material: For containers or container linings, use mild steel or high density polyethylene. Unsuitable material: PVC.
Container Advice	:	Polyethylene containers should not be exposed to high temperatures because of possible risk of distortion.

SECTION 8. EXPOSURE CONTROLS AND PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
Oil mist, mineral	Not Assigned	TWA (Mist)	5 mg/m3	OSHA Z-1
Oil mist, mineral		TWA (Inhalable particulate matter)	5 mg/m3	ACGIH
Butylated hydroxytoluene	128-37-0	TWA (Inhalable fraction and vapor)	2 mg/m3	ACGIH

Biological occupational exposure limits

No biological limit allocated.

Monitoring Methods

Monitoring of the concentration of substances in the breathing zone of workers or in the general workplace may be required to confirm compliance with an OEL and adequacy of exposure controls. For some substances biological monitoring may also be appropriate.
Validated exposure measurement methods should be applied by a competent person and samples analysed by an accredited laboratory.
Examples of sources of recommended exposure measurement methods are given below or contact the supplier. Further national methods may be available.

National Institute of Occupational Safety and Health (NIOSH), USA: Manual of Analytical Methods http://www.cdc.gov/niosh/

Occupational Safety and Health Administration (OSHA), USA: Sampling and Analytical Methods http://www.osha.gov/

Health and Safety Executive (HSE), UK: Methods for the Determination of Hazardous Substances http://www.hse.gov.uk/

Institut für Arbeitsschutz Deutschen Gesetzlichen Unfallversicherung (IFA) , Germany http://www.dguv.de/inhalt/index.jsp

L'Institut National de Recherche et de Securité, (INRS), France http://www.inrs.fr/accueil

Engineering measures : The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Select controls based on a risk assessment of local circumstances. Appropriate measures include:
Adequate ventilation to control airborne concentrations.

Where material is heated, sprayed or mist formed, there is greater potential for airborne concentrations to be generated.

General Information:
Define procedures for safe handling and maintenance of

controls.
Educate and train workers in the hazards and control measures relevant to normal activities associated with this product.
Ensure appropriate selection, testing and maintenance of equipment used to control exposure, e.g. personal protective equipment, local exhaust ventilation.
Drain down system prior to equipment break-in or maintenance.
Retain drain downs in sealed storage pending disposal or subsequent recycle.
Always observe good personal hygiene measures, such as washing hands after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned.
Practice good housekeeping.

Do not ingest. If swallowed, then seek immediate medical assistance

Personal protective equipment

Respiratory protection : No respiratory protection is ordinarily required under normal conditions of use.
In accordance with good industrial hygiene practices, precautions should be taken to avoid breathing of material.
If engineering controls do not maintain airborne concentrations to a level which is adequate to protect worker health, select respiratory protection equipment suitable for the specific conditions of use and meeting relevant legislation.
Check with respiratory protective equipment suppliers.
Where air-filtering respirators are suitable, select an appropriate combination of mask and filter.
Select a filter suitable for the combination of organic gases and vapours and particles [Type A/Type P boiling point >65°C (149°F)].

Hand protection
Remarks : Where hand contact with the product may occur the use of gloves approved to relevant standards (e.g. Europe: EN374, US: F739) made from the following materials may provide suitable chemical protection. PVC, neoprene or nitrile rubber gloves Suitability and durability of a glove is dependent on usage, e.g. frequency and duration of contact, chemical resistance of glove material, dexterity. Always seek advice from glove suppliers. Contaminated gloves should be replaced.
Personal hygiene is a key element of effective hand care. Gloves must only be worn on clean hands. After using gloves, hands should be washed and dried thoroughly. Application of a non-perfumed moisturizer is recommended.
For continuous contact we recommend gloves with breakthrough time of more than 240 minutes with preference for > 480 minutes where suitable gloves can be identified. For

short-term/splash protection we recommend the same but recognize that suitable gloves offering this level of protection may not be available and in this case a lower breakthrough time maybe acceptable so long as appropriate maintenance and replacement regimes are followed. Glove thickness is not a good predictor of glove resistance to a chemical as it is dependent on the exact composition of the glove material. Glove thickness should be typically greater than 0.35 mm depending on the glove make and model.

Eye protection : If material is handled such that it could be splashed into eyes, protective eyewear is recommended.

Skin and body protection : Skin protection is not ordinarily required beyond standard work clothes.
It is good practice to wear chemical resistant gloves.

Protective measures : Personal protective equipment (PPE) should meet recommended national standards. Check with PPE suppliers.

Thermal hazards : Not applicable

Environmental exposure controls

General advice : Local guidelines on emission limits for volatile substances must be observed for the discharge of exhaust air containing vapour.
Minimise release to the environment. An environmental assessment must be made to ensure compliance with local environmental legislation.
Information on accidental release measures are to be found in section 6.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Liquid at room temperature.
Colour	:	clear
Odour Threshold	:	Data not available
pH	:	Not applicable
pour point	:	<= -40 °C / <= -40 °F Method: ASTM D97
Initial boiling point and boiling range	:	> 280 °C / 536 °F estimated value(s)
Flash point	:	150 °C / 302 °F Method: ASTM D92 (COC)
Evaporation rate	:	Data not available

Flammability (solid, gas)	:	Data not available
Upper explosion limit / upper flammability limit	:	Typical 10 %(V)
Lower explosion limit / Lower flammability limit	:	Typical 1 %(V)
Vapour pressure	:	< 0.5 Pa (20 °C / 68 °F) estimated value(s)
Relative vapour density	:	> 1 estimated value(s)
Relative density	:	0.890 (15 °C / 59 °F)
Density	:	<= 910 kg/m3 (15.0 °C / 59.0 °F) Method: ASTM D1298
Solubility(ies)		
Water solubility	:	negligible
Solubility in other solvents	:	Data not available
Partition coefficient: n-octanol/water	:	log Pow: > 6 (based on information on similar products)
Auto-ignition temperature	:	> 320 °C / 608 °F
Decomposition temperature	:	Data not available
Viscosity		
Viscosity, dynamic	:	Data not available
Viscosity, kinematic	:	<= 76 mm2/s (0 °C / 32 °F) Method: ASTM D445 <= 3 mm2/s (100 °C / 212 °F) Method: ASTM D445 <= 12 mm2/s (40.0 °C / 104.0 °F) Method: ASTM D445
Explosive properties	:	Not classified
Oxidizing properties	:	Data not available
Conductivity	:	This material is not expected to be a static accumulator.

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	The product does not pose any further reactivity hazards in addition to those listed in the following sub-paragraph.
Chemical stability	:	Stable.
Possibility of hazardous reactions	:	Reacts with strong oxidising agents.
Conditions to avoid	:	Extremes of temperature and direct sunlight.
Incompatible materials	:	Strong oxidising agents.
Hazardous decomposition products	:	No decomposition if stored and applied as directed.

SECTION 11. TOXICOLOGICAL INFORMATION

Basis for assessment	:	Information given is based on data on the components and the toxicology of similar products.Unless indicated otherwise, the data presented is representative of the product as a whole, rather than for individual component(s).

Information on likely routes of exposure
Skin and eye contact are the primary routes of exposure although exposure may occur following accidental ingestion.

Acute toxicity

Product:

Acute oral toxicity	:	LD50 (rat): > 5,000 mg/kg Remarks: Low toxicity: Based on available data, the classification criteria are not met. Remarks: Aspiration into the lungs may cause chemical pneumonitis which can be fatal.
Acute inhalation toxicity	:	Remarks: Based on available data, the classification criteria are not met.
Acute dermal toxicity	:	LD50 (Rabbit): > 5,000 mg/kg Remarks: Low toxicity: Based on available data, the classification criteria are not met.

Skin corrosion/irritation

Product:

Remarks: Slightly irritating to skin., Prolonged or repeated skin contact without proper cleaning can clog the pores of the skin resulting in disorders such as oil acne/folliculitis., Based on available data, the classification criteria are not met.

Serious eye damage/eye irritation

Product:

Remarks: Slightly irritating to the eye., Based on available data, the classification criteria are not met.

Respiratory or skin sensitisation

Product:

Remarks: Not a skin sensitiser.
Based on available data, the classification criteria are not met.

Germ cell mutagenicity

Product:

: Remarks: Non mutagenic, Based on available data, the classification criteria are not met.

Carcinogenicity

Product:

Remarks: Not a carcinogen., Based on available data, the classification criteria are not met.

Remarks: Product contains mineral oils of types shown to be non-carcinogenic in animal skin-painting studies., Highly refined mineral oils are not classified as carcinogenic by the International Agency for Research on Cancer (IARC).

IARC	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.
NTP	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Reproductive toxicity

Product:

: Remarks: Not a developmental toxicant., Does not impair fertility., Based on available data, the classification criteria are not met.

STOT - single exposure

Product:

Remarks: Based on available data, the classification criteria are not met.

STOT - repeated exposure

Product:

Remarks: Based on available data, the classification criteria are not met.

Aspiration toxicity

Product:

Aspiration into the lungs when swallowed or vomited may cause chemical pneumonitis which can be fatal.

Further information

Product:

Remarks: Used oils may contain harmful impurities that have accumulated during use. The concentration of such impurities will depend on use and they may present risks to health and the environment on disposal., ALL used oil should be handled with caution and skin contact avoided as far as possible.

Remarks: Slightly irritating to respiratory system.

SECTION 12. ECOLOGICAL INFORMATION

Basis for assessment : Ecotoxicological data have not been determined specifically for this product.
Information given is based on a knowledge of the components and the ecotoxicology of similar products.
Unless indicated otherwise, the data presented is representative of the product as a whole, rather than for individual component(s).(LL/EL/IL50 expressed as the nominal amount of product required to prepare aqueous test extract).

Ecotoxicity

Product:

Toxicity to fish (Acute toxicity) :
Remarks: LL/EL/IL50 >10 <= 100 mg/l
Harmful

Toxicity to daphnia and other aquatic invertebrates (Acute toxicity) :
Remarks: LL/EL/IL50 >10 <= 100 mg/l
Harmful

Toxicity to algae (Acute toxicity) :
Remarks: LL/EL/IL50 >10 <= 100 mg/l
Harmful

Toxicity to fish (Chronic toxicity)	:	Remarks: Data not available
Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)	:	Remarks: Data not available
Toxicity to microorganisms (Acute toxicity)	:	Remarks: Data not available

Components:

Butylated hydroxytoluene:

M-Factor (Acute aquatic toxicity)	:	1

Persistence and degradability

Product:

Biodegradability	:	Remarks: Not readily biodegradable. Major constituents are inherently biodegradable, but contains components that may persist in the environment.

Bioaccumulative potential

Product:

Bioaccumulation	:	Remarks: Contains components with the potential to bioaccumulate.

Mobility in soil

Product:

Mobility	:	Remarks: Liquid under most environmental conditions. If it enters soil, it will adsorb to soil particles and will not be mobile. Remarks: Floats on water.

Other adverse effects

Product:

Additional ecological information	:	Does not have ozone depletion potential, photochemical ozone creation potential or global warming potential. Product is a mixture of non-volatile components, which will not be released to air in any significant quantities under normal conditions of use. Poorly soluble mixture. Causes physical fouling of aquatic organisms. Mineral oil does not cause chronic toxicity to aquatic organisms at concentrations less than 1 mg/l.

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues : Recover or recycle if possible.
It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste classification and disposal methods in compliance with applicable regulations.
Do not dispose into the environment, in drains or in water courses

Waste product should not be allowed to contaminate soil or ground water, or be disposed of into the environment.
Waste, spills or used product is dangerous waste.

Contaminated packaging : Dispose in accordance with prevailing regulations, preferably to a recognized collector or contractor. The competence of the collector or contractor should be established beforehand. Disposal should be in accordance with applicable regional, national, and local laws and regulations.

Local legislation

Remarks : Disposal should be in accordance with applicable regional, national, and local laws and regulations.

SECTION 14. TRANSPORT INFORMATION

National Regulations

US Department of Transportation Classification (49 CFR Parts 171-180)

Not regulated as a dangerous good

International Regulations

IATA-DGR
Not regulated as a dangerous good

IMDG-Code
Not regulated as a dangerous good

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable for product as supplied. MARPOL Annex 1 rules apply for bulk shipments by sea.

Special precautions for user

Remarks : Special Precautions: Refer to Section 7, Handling & Storage, for special precautions which a user needs to be aware of or needs to comply with in connection with transport.

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know Act

*: This material does not contain any components with a CERCLA RQ., Shell classifies this material as an "oil" under the CERCLA Petroleum Exclusion, therefore releases to the environment are not reportable under CERCLA.

SARA 304 Extremely Hazardous Substances Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 302 Extremely Hazardous Substances Threshold Planning Quantity

This material does not contain any components with a section 302 EHS TPQ.

SARA 311/312 Hazards : Aspiration hazard

SARA 313 : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

Clean Water Act

This product does not contain any Hazardous Chemicals listed under the U.S. CleanWater Act, Section 311, Table 117.3.

US State Regulations

Pennsylvania Right To Know

Distillates (petroleum), hydrotreated light naphthenic	64742-53-6

California Prop. 65

This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

California List of Hazardous Substances

Distillates (petroleum), hydrotreated light naphthenic	64742-53-6

Other regulations:

The regulatory information is not intended to be comprehensive. Other regulations may apply to this material.

The components of this product are reported in the following inventories:

EINECS : Notified with Restrictions.

TSCA : All components listed.

DSL : All components listed.

SECTION 16. OTHER INFORMATION

Further information

NFPA Rating (Health, Fire, Reactivity)	1, 1, 0

Full text of other abbreviations

ACGIH	:	USA. ACGIH Threshold Limit Values (TLV)
OSHA Z-1	:	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
ACGIH / TWA	:	8-hour, time-weighted average
OSHA Z-1 / TWA	:	8-hour time weighted average
Abbreviations and Acronyms	:	The standard abbreviations and acronyms used in this document can be looked up in reference literature (e.g. scientific dictionaries) and/or websites. ACGIH = American Conference of Governmental Industrial Hygienists ADR = European Agreement concerning the International Carriage of Dangerous Goods by Road AICS = Australian Inventory of Chemical Substances ASTM = American Society for Testing and Materials BEL = Biological exposure limits BTEX = Benzene, Toluene, Ethylbenzene, Xylenes CAS = Chemical Abstracts Service CEFIC = European Chemical Industry Council CLP = Classification Packaging and Labelling COC = Cleveland Open-Cup DIN = Deutsches Institut fur Normung DMEL = Derived Minimal Effect Level DNEL = Derived No Effect Level DSL = Canada Domestic Substance List EC = European Commission EC50 = Effective Concentration fifty ECETOC = European Center on Ecotoxicology and Toxicology Of Chemicals ECHA = European Chemicals Agency EINECS = The European Inventory of Existing Commercial Chemical Substances EL50 = Effective Loading fifty ENCS = Japanese Existing and New Chemical Substances Inventory EWC = European Waste Code GHS = Globally Harmonised System of Classification and Labelling of Chemicals IARC = International Agency for Research on Cancer IATA = International Air Transport Association IC50 = Inhibitory Concentration fifty IL50 = Inhibitory Level fifty IMDG = International Maritime Dangerous Goods INV = Chinese Chemicals Inventory IP346 = Institute of Petroleum test method N° 346 for the determination of polycyclic aromatics DMSO-extractables KECI = Korea Existing Chemicals Inventory LC50 = Lethal Concentration fifty LD50 = Lethal Dose fifty per cent. LL/EL/IL = Lethal Loading/Effective Loading/Inhibitory loading

LL50 = Lethal Loading fifty
MARPOL = International Convention for the Prevention of Pollution From Ships
NOEC/NOEL = No Observed Effect Concentration / No Observed Effect Level
OE_HPV = Occupational Exposure - High Production Volume
PBT = Persistent, Bioaccumulative and Toxic
PICCS = Philippine Inventory of Chemicals and Chemical Substances
PNEC = Predicted No Effect Concentration
REACH = Registration Evaluation And Authorisation Of Chemicals
RID = Regulations Relating to International Carriage of Dangerous Goods by Rail
SKIN_DES = Skin Designation
STEL = Short term exposure limit
TRA = Targeted Risk Assessment
TSCA = US Toxic Substances Control Act
TWA = Time-Weighted Average
vPvB = very Persistent and very Bioaccumulative

A vertical bar (|) in the left margin indicates an amendment from the previous version.

Sources of key data used to compile the Safety Data Sheet	:	The quoted data are from, but not limited to, one or more sources of information (e.g. toxicological data from Shell Health Services, material suppliers' data, CONCAWE, EU IUCLID date base, EC 1272 regulation, etc).
Revision Date	:	04/02/2020

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

US / EN