

AIRCRAFT ALTERNATOR MAINTENANCE MANUAL

P/N ES1031

ALTERNATOR MODELS

ES-10024B-1

ES-10024B-2

ES-10024B-3

ES-10024B-4

ES-10024B-5

ES-10024B-5LS

ES-10024

ALV-9610

ES-6024D

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REFERENCES

- A. PP2002 - AIRCRAFT ALTERNATOR OVERHAUL MANUAL, ALTERNATOR MODELS: ES-10024 & ALV-9610

Thank you for purchasing a PlanePower* alternator. We encourage you to read this manual thoroughly. It contains a wealth of information about how to properly install and maintain your alternator so that it may give you many years of safe and reliable service.

Should you have a question regarding your alternator that is not covered in the manual, Hartzell Engine Technologies Product Support is ready to assist you. We may be reached at the following contact information:

Phone: +1.334.386.5400, option 2

E-mail: techsupport@HartzellEngineTech.com

Fax: +1.334.386.5450

Web: www.Hartzell.aero/contact/

*PlanePower is a trademark of Hartzell Engine Technologies LLC

WARNING:

People who fly should recognize that there are various types of risks are involved in this activity; and they should take all precautions to minimize them, since they cannot be eliminated entirely. The alternator is an important component of the aircraft. An alternator failure could result in an unplanned landing or even more severe consequences creating an unsafe condition that may result in death, serious bodily injury, and/or substantial property damage. It is, therefore, essential that the alternator is properly maintained according to the recommended service procedures and monitored to detect impending problems before they become serious. Any unusual operation should be investigated and corrected, as it may be a warning of impending failure.

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RECORD OF REVISIONS

Revision Level	Issue Date	Page(s) Revised	Description	Date
New	5/05/16	N/A	New Release	5/05/16
A	8/11/21	All	<p>Approved via PCO-110543; Formatted to comply with FAA Order 8100.54, Appdx A; Replace Hartzell Engine Technologies logo with PlanePower logo;</p> <p>i Change "Owner's" to "Maintenance"; List alternator models affected, remove -() from model numbers;</p> <p>ii Update copyright date;</p> <p>iii Update Table of Contents;</p> <p>v Add References section;</p> <p>vi Add "*PlanePower is a trademark of Hartzell Engine Technologies LLC";</p> <p>1-2 Add para.1.2 H. Changes and Updates; Change ES-10024B-() to ES-10024B-1 thru -5 and 5LS;</p> <p>1-3 Change SI Units: Ah to A · h, N.m to N · m; Change U.S. Units: lbf/in to lbf · in, lb/ft to lbf · ft;</p> <p>1-6 Para. 1.9, change ES-10024B-() to ES-10024B-1 thru -5 and 5LS;</p> <p>2-2 Update Operational Data and Dimensions paragraphs;</p> <p>2-3 Update dimensions illustration, Figure 2.3;</p> <p>2-4 thru 2-7 Add basic dimension illustrations for ES10024B-1, -2, -3, -4, -5, -5LS model alternators;</p> <p>2-8 Add basic dimension illustration for 6024D alternator;</p> <p>2-11 Update Figure 2.12 to show alternator exploded view, typical;</p> <p>2-12 Table 2.1, change temperature ranges to N/A; Change Minimum regulation speed from 2,200 RPM to 1,800 RPM; Filter Type: Change 50 µF to .50 µF; Field Resistance: Change 6.3-6.7 ohm to 14.9-15.4 ohm; Change * 50 µF to .47 µF;</p> <p>3-8 Para. 3.3 B.(3), add "and correct the issue";</p> <p>5-4 & 5-5 Update para. 5.4, Alternator Bench Testing;</p> <p>5-8 thru 5-11 Add test illustrations 5-1 thru 5-5;</p> <p>6-2 Update torque value, Table 6-1, Figure 6.1 (gear), "Output Shaft Nut", from 37-42 ft-lbs to 25.0-37.5 ft-lbs;</p> <p>6-5 Table 6.2, remove alternator ES10024B-7 not covered under scope of manual;</p> <p>6-12 Para. 6.11, Materials, update various part numbers;</p> <p>6.13 Para. 6.15, add sub-paragraph A.</p>	8/11/21

RECORD OF REVISIONS

Revision Level	Issue Date	Page(s) Revised	Description	Date

RECORD OF TEMPORARY REVISIONS

Temporary Rev. Letter	Page Number	Issue Date	By	Date Removed	By

AIRWORTHINESS LIMITATIONS

A.1 General Information

CAUTION:



THE AIRWORTHINESS LIMITATIONS HEREIN ARE THOSE MANDATED BY HARTZELL ENGINE TECHNOLOGIES. THESE LIMITATIONS ARE THE MINIMUM REQUIRED TO MEET CONTINUED AIRWORTHINESS BUT MAY BE SUPERSEDED BY MORE STRINGENT REQUIREMENTS AS PUBLISHED BY THE FAA, AIRCRAFT, ROTORCRAFT OR OTHER MANUFACTURERS THAT USE THESE COMPONENTS IN THEIR APPLICATIONS. FAILURE TO OBSERVE THESE LIMITATIONS MAY COMPROMISE THE COMPONENT OR THE APPLICATION IT IS USED IN.

A.2 Airworthiness Limitations Statement

- A. The Airworthiness Limitations section is FAA accepted and specifies maintenance required under § 43.16 and § 91.403 of the Federal Aviation Regulations unless an alternative program has been FAA approved.

Airworthiness Limitation Revisions Log

Revision Number	Description of Revision

A.3 Life Limits

- A. The FAA establishes specific life limits for certain component parts as well as the complete starter adapter. Such limits require replacement of the identified parts after a specified number of cycles or hours of use.

- B. Additions of, or changes to, any life limit for alternator components will be noted in the Airworthiness Limitation Revision Log.

- C. Life Limits
 - (1) Alternator models and their component parts affected by this manual currently do not have any life limited parts.

 - (2) There are no new (or additional) Airworthiness Limitation associated with this equipment.

CHAPTER 1 - INTRODUCTION

1.1 General Information

WARNING:

IMPROPER OR UNAUTHORIZED APPLICATIONS OF THE INFORMATION CONTAINED IN THE MANUAL MAY RENDER THE AIRCRAFT OR THE COMPONENT UNAIRWORTHY AND RESULT IN LOSSES, DAMAGES, OR INJURY TO THE USER.



DO NOT USE OBSOLETE OR OUTDATED INFORMATION. PERFORM ALL INSPECTIONS OR WORK IN ACCORDANCE WITH THE MOST RECENT REVISION OF THE APPLICABLE AIRCRAFT/ENGINE SERVICE OR MAINTENANCE MANUAL. INFORMATION CONTAINED IN THESE MANUALS MAY BE SIGNIFICANTLY CHANGED FROM EARLIER REVISIONS. USE OF OBSOLETE INFORMATION MAY CREATE AN UNSAFE CONDITION THAT MAY RESULT IN DEATH, SERIOUS BODILY INJURY, AND/OR SUBSTANTIAL PROPERTY DAMAGE.

The accuracy and applicability of this manual has not been verified for any assembly, component or part not manufactured by Hartzell Engine Technologies LLC (HET). Any use of the manual for other than its intended or implied purpose is prohibited. The use of the manual for the purpose of performing any installation, maintenance, replacement, adjustment, or inspection of any assembly, component or part not manufactured by HET is not approved, endorsed, or sanctioned by HET.

This manual has been approved by Hartzell Engine Technologies LLC as the proper methods and procedures that FAA or other airworthiness authority Certificated Repair Stations and A/P Mechanics should use in the inspection and maintenance of Hartzell Engine Technologies LLC alternators.

No liability will be assumed by Hartzell Engine Technologies LLC for actual, consequential, incidental or other types of damages directly or indirectly resulting from the unauthorized use of this manual for other than its stated purposes.

The liability for use of the authorized data herein for the maintenance, or return to service is limited to the specific terms and conditions stated under the applicable Limited Warranty in effect for each piece part, component, assembly or whole unit sold by HET.

Because of the numerous modifications, Supplemental Type Certificates (STC), Parts Manufacturing Approvals (PMA), or Form 337 Field Approvals that may apply, it is the responsibility of the repairman, mechanic or maintenance facility to determine the proper engine or aircraft application of this alternator assembly. Please refer to the appropriate aircraft Type Certificate (TC), Supplemental Type Certificate (STC), aircraft equipment list, maintenance manuals, and/or Log Book entries for determination.

When performing installation, maintenance, replacement, adjustment, or inspection of any HET assembly, component or part, it is imperative that the latest revision of this HET manual or other product support document be referenced. Reference the HET website to be sure you have the latest revision before performing any work. (<http://www.hartzell.aero/maintenance-manuals/>)

All reasonable attempts were made to make this manual as complete and accurate as possible. If you have any questions, comments, corrections or require clarification of any information contained herein, please write to Hartzell Engine Technologies LLC, 2900 Selma Highway, Montgomery, Alabama, 36108 USA. TEL +1.334.386.5400, FAX +1.334.386.5410, or <http://hartzell.aero/contact/>.

1.2 General Specification (manual)

- A. This manual follows general GAMA guidelines using ATA 100 identification as required. Principle units of measure used in the manual are U.S. units with International System of Units (SI) in parentheses.
- B. The ALV-9610, ES-10024, ES-10024B-1 thru -5 and 5LS, and ES-6024D series (24v) alternator models are considered herein.
- C. All aircraft, rotorcraft, or engine applications are limited to the holder of the TC, STC, PMA or TSO and only at the date of that document publication or revision.
- D. Only approved, competent persons with the necessary skills may do maintenance tasks described in the manual. This may include a certified pilot doing “preventative maintenance” as defined in FAR 43, Appendix A, paragraph C with guidance from AC 43.12A of latest change.
- E. The manual describes maintenance on components as they are installed on aircraft and tasks that should be accomplished in a properly equipped service facility.
- F. Maintenance tasks and subtasks are referenced in the manual but will have no specific identification numbers.
- G. The manual contains: Description and operation, Troubleshooting, Instruction for Continued Airworthiness (ICA) and Maintenance information along with part numbers required for basic maintenance tasks.
- H. Changes and updates to this manual can be found at www.PlanePower.aero. Revisions will be tracked and recorded in the Record of Revisions section of this document.

1.3 How to use the manual

- A. Make sure the manual contains information applicable to your aircraft, engine, or replacement alternator. Look for the model number on the Title Page and if applicable, the part number of the replacement or superseded component.
- B. It is imperative that you read, understand, and observe all the applicable WARNINGS and CAUTIONS before you do any work on this component.
- C. Use only the sections needed, use the check section to determine what actions may be needed periodically and the maintenance sections for servicing the alternator.
- D. If you need to identify a part or find a part number, refer to illustrations herein or the applicable aircraft or engine service or maintenance manual.
- E. Refer to the troubleshooting section to assure that the observed or reported condition lies with the alternator.
- F. Fully test the alternator per the instructions in this manual when running the aircraft. Utilize the aircraft and/or engine manufacturer’s service manuals and publications before returning the aircraft to service. Use the AFM or POH for aircraft operations.
- G. Some sections in this manual apply to all alternators considered herein. Other sections will contain information specific to a particular alternator model or variation of a model.

1.4 Measurements

The measurements given in this manual are taken from original manufacturing drawings.

1.5 Units of Measure

A. SI Units

A	Ampere
A · h	Ampere hours
g	Gram
N	Newton
N · m	Newton meter
V	Volt
°C	Degree Celsius
Ω	Ohm
W	Watt
Hz	Hertz
m	Meter
cm	Centimeter
kg	Kilogram

B. U.S. Units

ft	Foot
in	Inch
lb	Pound
lbf · in	Pound-force inch
lbf · ft	Pound-force foot
°F	Degree Fahrenheit

C. Multiplying Prefixes

μ	Micro
m	Milli
k	Kilo
M	Mega
p	Pico

1.6 Abbreviations

A. The abbreviations given below are used in the manual: (upper or lower case)

ACU	Alternator Control Unit
AFM	Aircraft Flight Manual
ALT	Alternator
ATA	Air Transport Association of America
CMI	Continental Motors, Inc.
DE	Drive End (housing)
DIA	Diameter
FAA	Federal Aviation Administration (USA)
FIG.	Figure
GAMA	General Aviation Manufacturers Association
IPC	Illustrated Parts Catalog
ID	Inside Diameter
HET	Hartzell Engine Technologies LLC
MAX	Maximum
MFR	Manufacturer
MIN	Minimum
NO.	Number
N/A	Not Applicable
OD	Outside Diameter
PCB	Printed Circuit Board
P/N	Part Number
PARA.	Paragraph
POH	Pilots Operating Handbook
REF.	Refer To
S/A	Subassembly
S/N	Serial Number
SRE	Slip Ring End (housing)
TBD	To Be Defined
TOL	Tolerance

1.7 Definitions

A. This paragraph defines the warnings and notifications used in this manual. **WARNINGS** place critical attention to use of tools, materials, procedures, or limitations, which must be followed without deviation to avoid injury to the technician or other persons. **CAUTIONS** place immediate attention to use of tools and procedures which must be followed to avoid injury, damage to equipment and/or facilities. **Notes** call attention to procedures which make the job easier.

B. The following are basic definitions of the terms used herein: (as related to this manual)

ALTERNATOR: The complete unit which transforms rotational energy from a powerplant into electrical energy . At a given voltage, produces alternating current (AC) which is converted to direct current (DC).

ALTERNATOR CONTROL UNIT: Device which controls alternator functions on, off, regulation of high/low voltage, field current and output current.

AMMETER: The device for measuring current in amperes.

BRUSH: Device for conducting current to the slip rings of the rotor. It is a composite carbon block which includes a spring, lead and contact.

BRUSH HOLDER: Device that retains multiple brush assemblies and is comprised of a holder, contacts, and terminals.

CONTINUITY: The continuous path for the flow of current in an electrical circuit.

COOLING COVER: Device attached to the alternator to provide cooling air from an external source. May be provided with alternator or required by the airframe manufacturer. (Also known as the “Blast Tube”, referring to ram air cooling source.)

EMI: Electro Magnetic Interference. A disturbance in the radio-frequency spectrum that is generated by an external source that affects electrical devices or circuits by electromagnetic induction, electrostatic coupling, or conduction.

FRONT HOUSING: Part of the external housing which contains the components of the alternator. This end has structure typically used for mounting. It may also be referred to as the Drive End Housing or D.E.

INSULATOR: Component that does not allow electricity to flow through it easily. Insulators do not allow electricity to flow through them easily because the electrons in their atoms do not move easily from atom to atom.

MULTIMETER: Device for the measurement of voltage, current, or resistance.

LEAKAGE: Dissipation of voltage or current from a component or connection.

OPEN: Electrical term for a complete disruption of a conductive path in an electrical circuit. Will read infinite resistance.

PEAK INVERSE VOLTAGE: (PIV) The maximum rated value of a AC voltage acting in the direction opposite to that in which a device is designed to pass current.

PHASE: The position of a point in time (instant) on a waveform cycle. A complete cycle is defined as 360 degrees of phase. Phase can also be an expression of relative displacement between or among waves having the same frequency. In our case the alternator is three phase or 120 degrees separation.

POLARIZE: To induce polarization i.e., the partial or complete polar separation of positive and negative electric charge in an electrical system.

REAR HOUSING: Part of the external housing which contains the components of the alternator. It may also be referred to as the Slip Ring End or S.R.E.

RECTIFIER: An electrical circuit used to convert AC into DC current. The rectifier is an arrangement of diodes that causes the current to flow in only one direction.

RFI: Radio Frequency Interference. Electromagnetic energy in the radio-frequency spectrum. Electrical interference may be created by poor slip ring/brush connection, defective rectifiers, or other poor connections. This is a normal by-product of electrical generators.

ROTOR: Rotating electro magnet used to create a magnetic field. **SLIP RING:** Device which provides a sliding contact surface for the brush assemblies. The slip rings are smooth surface copper “rings” pressed onto the rotor shaft.

SHORT: Common term for a connection which has no or very little resistance as seen on an Ohmmeter in an electrical circuit. Typically an undesirable condition with respect to grounded elements.

STATOR: A stationary set of conductors wound in coils on an iron core.

TEST BENCH: Device so constructed as to allow testing of the alternator or component parts.

TERMINALS: Studs, screws or other devices that provide connections for electrical power.

THROUGH BOLT: Special bolts which connect front and rear alternator housings.

VOLT/OHM METER: Device for the measurement of voltage or resistance.

WOODRUFF KEY: Device used to capture the pulley or other drive device and aid in coupling torque from the powerplant source to the alternator's rotating shaft. Normally half moon in shape.

1.8 Disposal

- A. The alternator assembly is designed to allow for re-use of many alternator subassemblies and components. Disposal of unairworthy parts and assemblies as well as required replacement parts should be as follows: Rejected parts should be tagged and scrapped per FAA requirements. Any part deemed unairworthy must be rendered unusable prior to discard. Rectifiers and PCB components may be considered hazardous waste and should be discarded whole through your local hazardous waste management system.

1.9 Model Identification

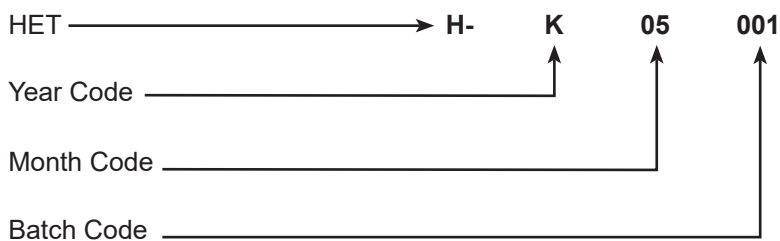
ALV-9610 Gear Driven (24 Volt)

ES-10024 Gear Driven (24 Volt)

ES-10024B-1 thru -5 and 5LS Belt Driven (24 Volt)

ES-6024D Gear Driven (24 Volt)

1.10 Serial number Identification



Example above: 2010, May, first unit of the month (batch). The year code advances one letter in alphabetical order for each succeeding year.

1.11 Warranties

- A. Hartzell Engine Technologies LLC (HET) offers a Limited warranty with each new, overhauled, or rebuilt Alternator assembly or component (parts) it sells through its distribution system. **NO expressed or implied warranty exists** when repairing, overhauling, or rebuilding any assembly or component using this manual except as it may apply to any new HET replacement part purchased. If you suspect that any warranty applies to the Alternator assembly, it must be returned through an authorized HET distributor in a manner prescribed by that specific distributor. The affected Alternator must be received by the factory fully assembled and not altered in any way for disposition by the HET warranty department. **(Warranty shall be denied for any alternator received altered, modified, or disassembled.)**
- B. The HET Limited warranty policy in effect for your Alternator was delivered with the unit at the time of purchase. (As the Warranty policy is revised from time to time, you must check the policy delivered with your unit for specific terms and conditions should a warranty condition occur. If needed for reference, obtain the most current policy from the authorized HET distributor nearest you -or- visit our website at www.hartzell.aero.)

CHAPTER 2 - DESCRIPTION OF OPERATION

2.1 Description

A. General

- (1) Hartzell Engine Technologies (HET) small frame, gear and belt driven alternators have been designed and constructed to provide extended periods of trouble-free operation with a minimum amount of maintenance. They are intended to withstand the vibration and extreme temperature changes encountered in aircraft applications. Basic features are identified in Fig. 2.1 thru 2.10 below.

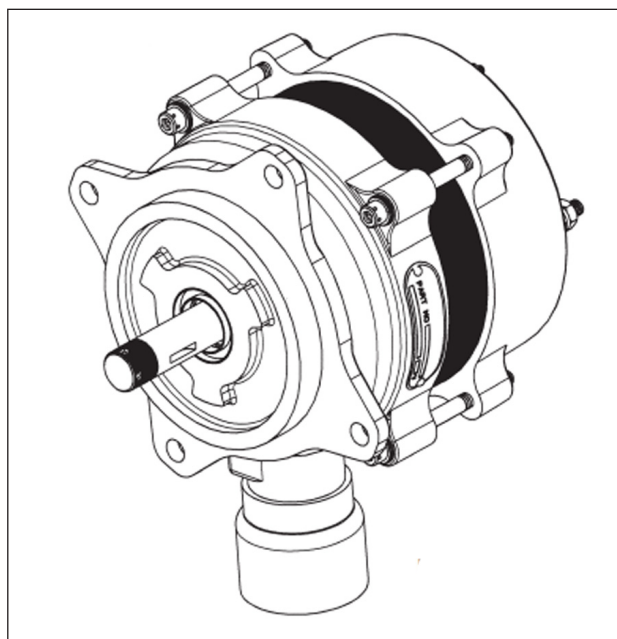


Figure 2.1 Typical Front View

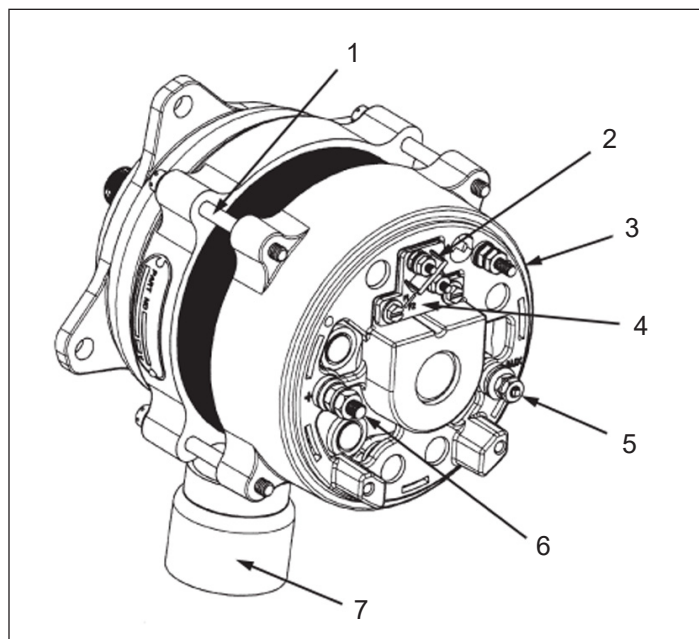


Figure 2.2 Typical Rear View

1. Through-Bolts (4 ea.)
2. Field Terminal
3. Ground Terminal (-)
4. Brush Assembly

5. Aux Terminal
6. Output Terminal (+)
7. Flexible Cooling Duct (ALV-9610 only)

B. Operational Data

Gear Driven	-
Air Cooled	-
Belt Driven (ES10024B)	-
External fan cooling (ES10024B)	-
Operating Speed (Minimum for Regulation):	2,200 RPM
Maximum Continuous Operating Speed:	10,000 RPM
Operating Output (Rated):	28.0 volts, 100 amps
Maximum Operating Altitude:	31,900 feet MSL (9,723 meters MSL)
Weight:	See Table 2-1, this chapter

C. Dimensions

- (1) The basic dimensions of each alternator are shown in Fig. 2.3 thru 2.10.
- (2) The dimensions of the ALV-9610 alternator are the same for the ES-10024 alternator with the exception of the flex cooling duct.

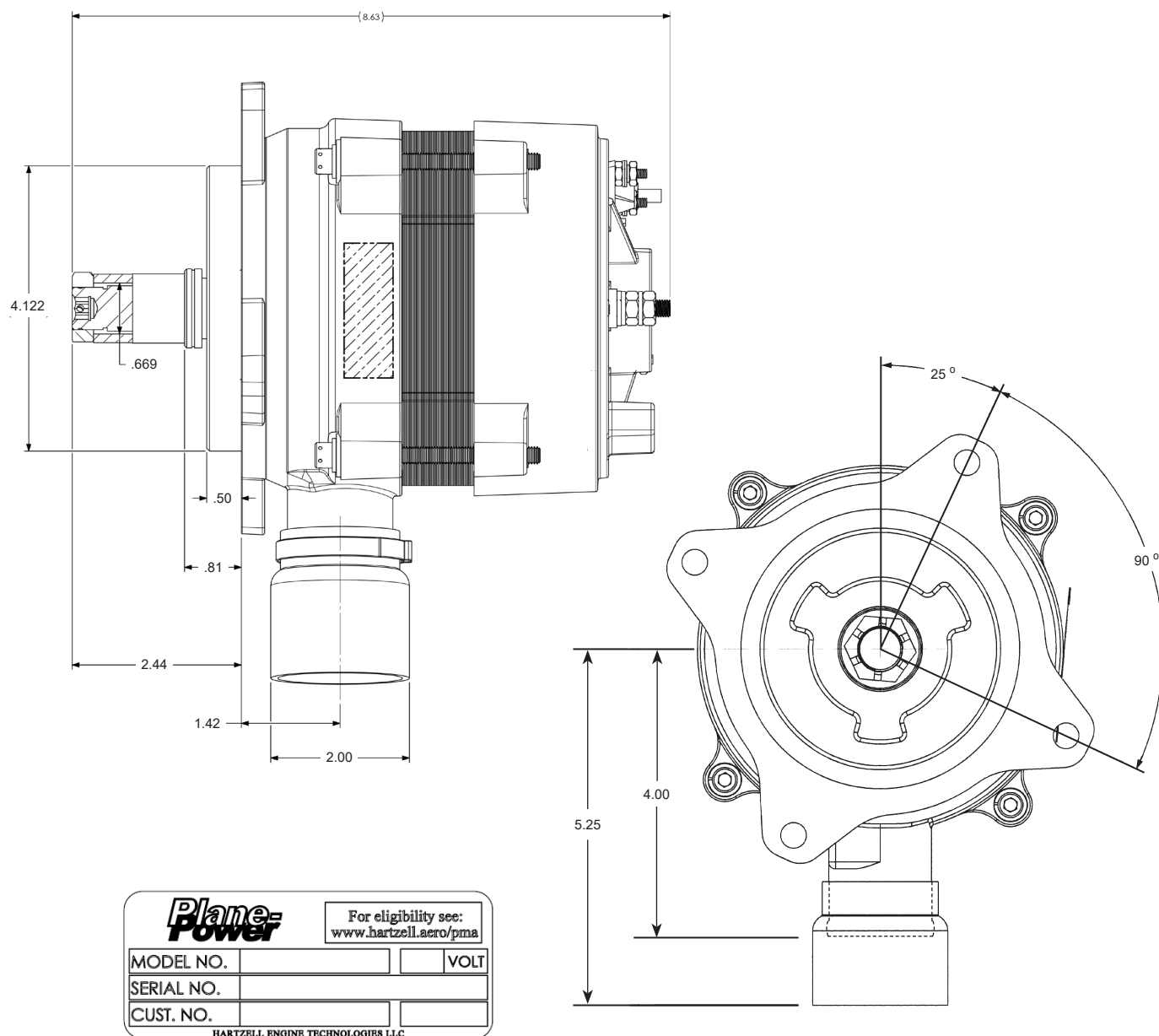


Figure 2.3 ES-10024/ALV-9610 Dimensions

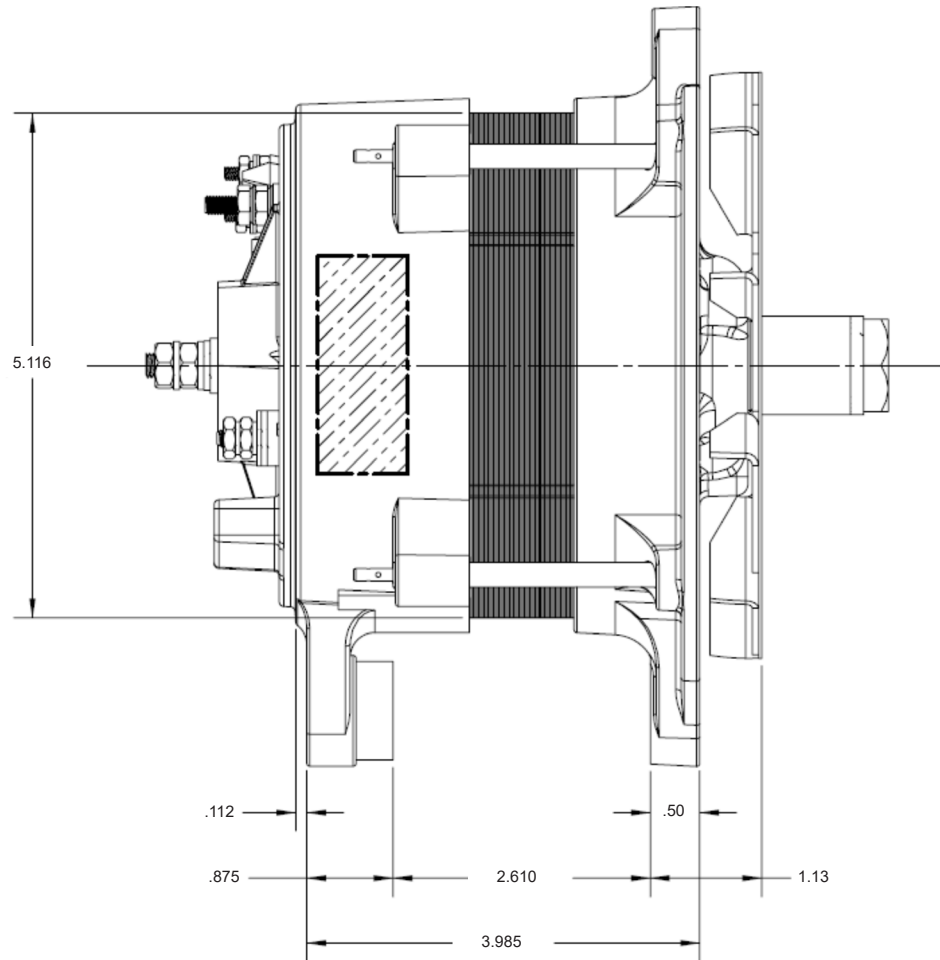


Figure 2.4 ES-10024B-1 & 10024B-5LS Dimensions

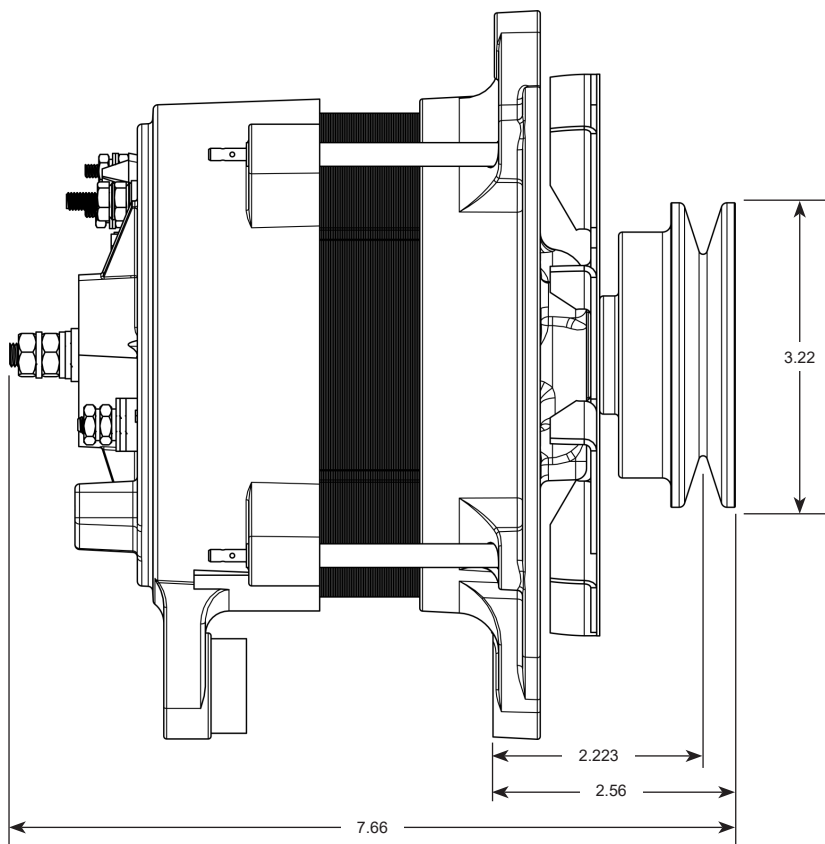
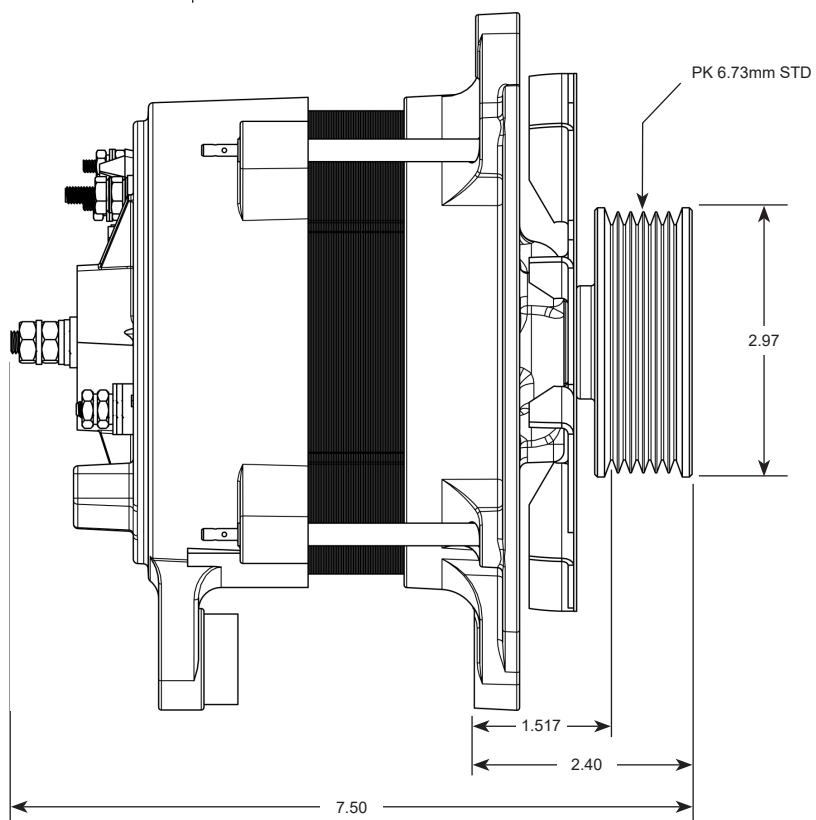


Figure 2.5 ES-10024B-2 Dimensions

Figure 2.6 ES-10024B-3 Dimensions



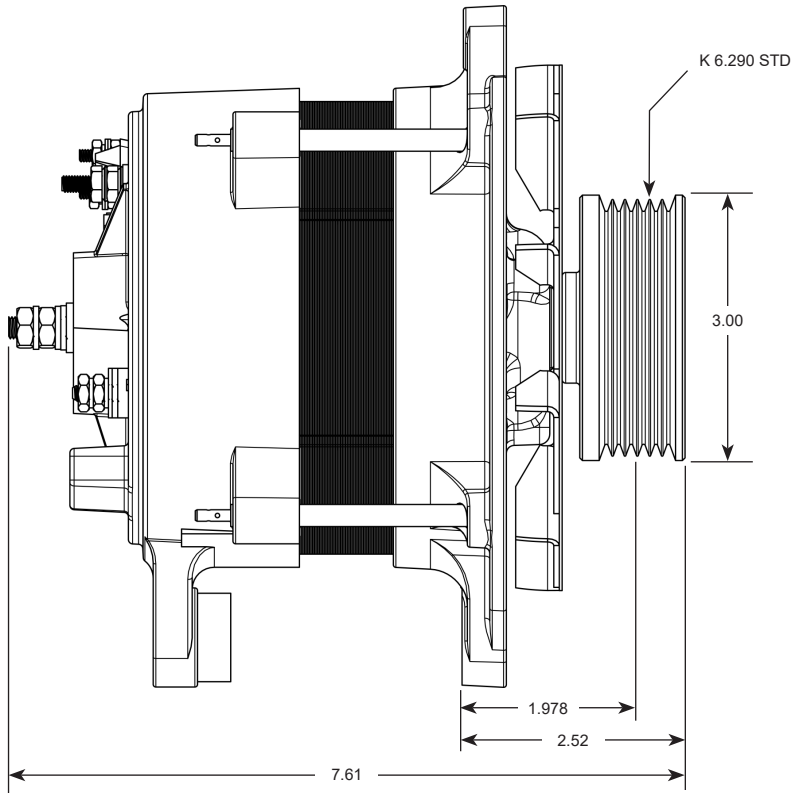
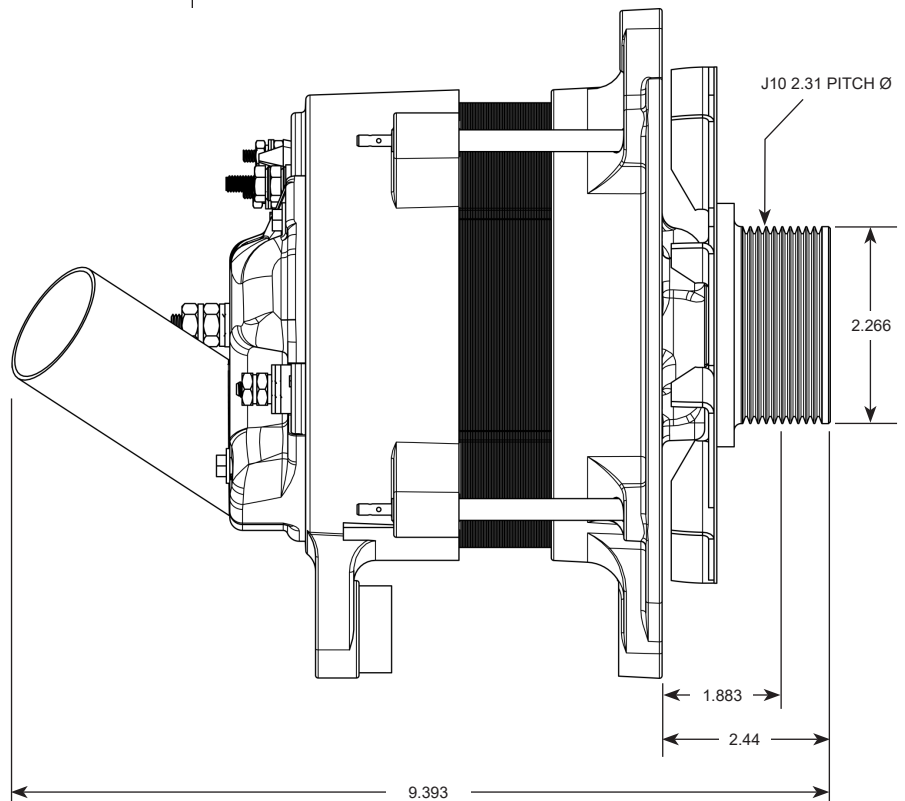


Figure 2.7 ES-10024B-4 Dimensions

Figure 2.8 ES-10024B-5 Dimensions



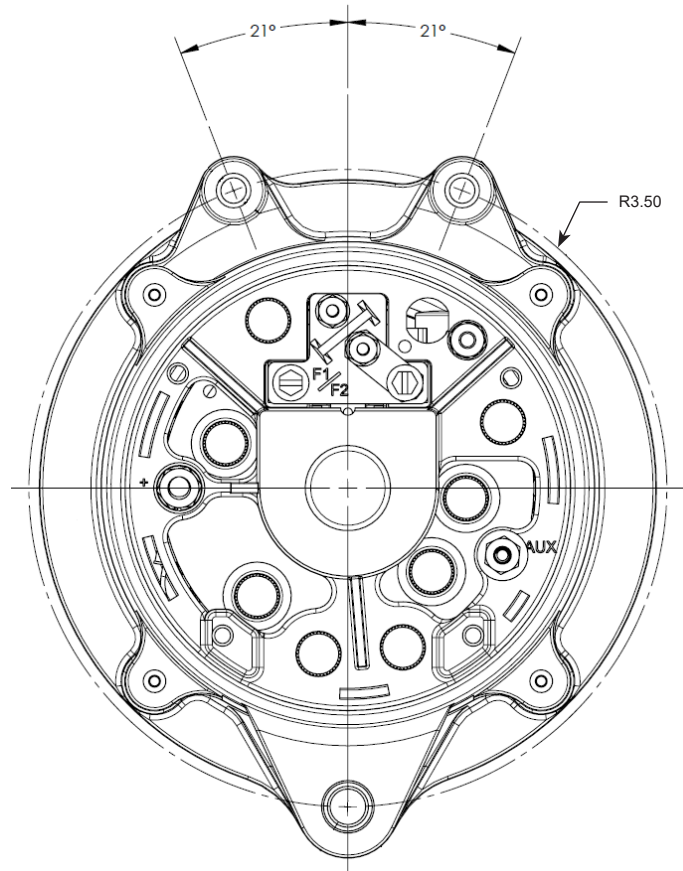


Figure 2.9 ES-10024B-1 thru - 4 & -5LS
ES-10024B-5 (Less blast tube cover)

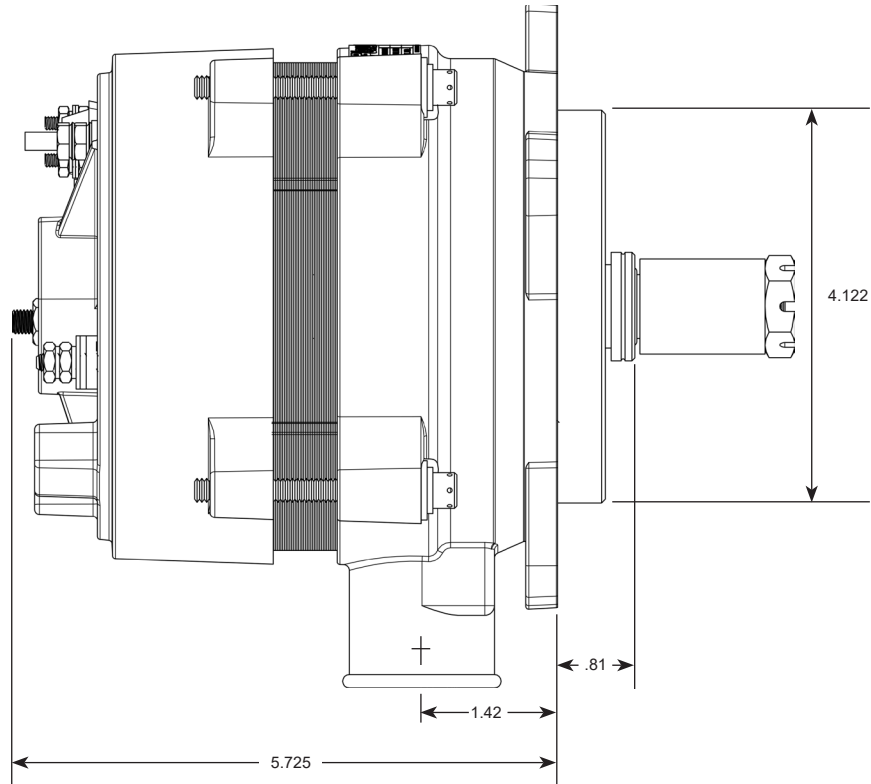


Figure 2.10 6024D Dimensions

2.2 Basic Component Description

- A. The principle components of the aircraft alternators described herein are the slip ring end housing assembly with bearing, the rectifier assembly, the stator, the rotor, the drive end housing assembly with bearing and the brush holder assembly with spring and brushes.
- B. A simplified electrical diagram is shown in Figure 2.11 which shows the basic electrical operating points and connections.

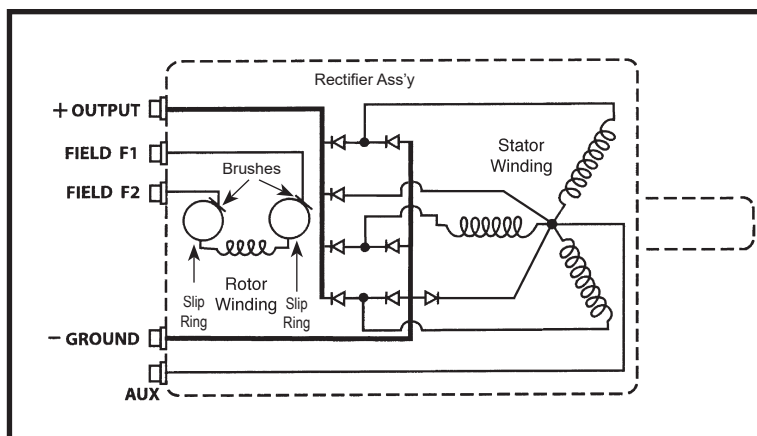


Figure 2.11 - Basic Diagram

2.3 Technical Purpose

- A. The purpose of the alternator is to produce electrical energy. This energy is used to maintain the proper state of charge in the battery and supply current to the electrically powered equipment and accessories in the aircraft. It performs this function by converting mechanical energy derived from its rotating parts into electricity.
 - (1) The BATTERY is the source of electrical power whenever the BAT Master Switch is ON and is the source of power for starting the aircraft. Once started, the ALTERNATOR becomes the electrical power source whenever the engine is running and the ALT Switch is turned ON. (Control systems may vary with the aircraft/rotorcraft.)

2.4 Physical Detail

- A. The brush holder assembly consists of a brush holder housing and two brush assemblies. The brush assemblies are made from a carbon-graphite brush having a flexible braided copper wire lead fitted to a coil spring. Each brush is electrically connected to a separate terminal stud mounted in the brush holder housing. These studs are the F1 and F2 terminals. The brush holder assembly is mounted in the SRE housing in a position and manner that allows one brush to ride on each ring providing for a continuous sliding electrical connection while the rotor spins.
- B. The rotor assembly is composed of a shaft, two pole-shoes, a coil assembly and a slip ring assembly. The coil assembly is a simple enameled-wire coil wound on a bobbin form. The coil is fitted between two iron pole-shoes which serve as magnetic flux guides. The rotor shaft is pressed through the pole-shoes forming a heavy interference fit making a permanent assembly fixing the poles in place on the shaft. The slip ring assembly is composed of two copper rings mounted on a non-metallic, insulating hub. The hub is fixed to the rotor shaft with one ring electrically connected to each end of the coil assembly winding.
- C. The stator assembly is formed by winding three separate coils of enameled copper wire on a common laminated iron core. The coils are symmetrically spaced around the core and overlap one another. Slot insulators are used to protect the windings from abrasion damage due to contact with the core. For Wye-connected stators, one end of each coil is joined in a common connection. The opposite ends of each coil remain free, resulting in four coil leads emanating from the stator assembly. These leads are electrically connected to the bridge rectifier network.
- D. The auxiliary terminal is electrically isolated from but mechanically mounted to the heat sink and SRE housing. It is electrically connected to one end of one stator winding and provides an electrical voltage signal that varies in a sinusoidal manner with frequency changing directly with speed.
- E. A full-wave bridge rectifier is formed from discrete positive and negative diodes mounted within the alternator. The positive rectifiers are installed in a crescent-shaped aluminum heat sink. The mechanical connection between the rectifier casings and the heat sink forms the positive electrical connection for the bridge leaving the heat-sink electrically energized. As such, the heat sink is mounted in a manner that keeps it electrically isolated from the alternator housings. The alternator's battery terminal (B+) is mechanically and electrically connected to the heat sink. The negative rectifiers are installed in the SRE housing, which also acts as a heat sink. The mechanical connection between the rectifier casings and the housing forms the ground electrical connection for the bridge. The alternator's ground terminal is mechanically and electrically connected to the SRE housing.
- F. The rotor assembly is supported by bearings at either end allowing the rotor to spin freely. The bearings are mounted in the DE and SRE housings. The stator assembly is so arranged within the DE and SRE housings as to align concentrically with the rotor assembly. The laminated iron core of the stator assembly surrounds the pole-shoes of the rotor assembly. The slip rings align with the brushes so as to allow one brush to contact one ring.
- G. Most models feature an electrical filter designed to minimize EMI and RFI noise. This filter is a conventional metal case capacitor with an integrated mounting tab. (Early models may have an internal PCB (printed circuit board) incorporating a capacitor and gas-discharge tube.) Both types perform the same function and provide similar performance.

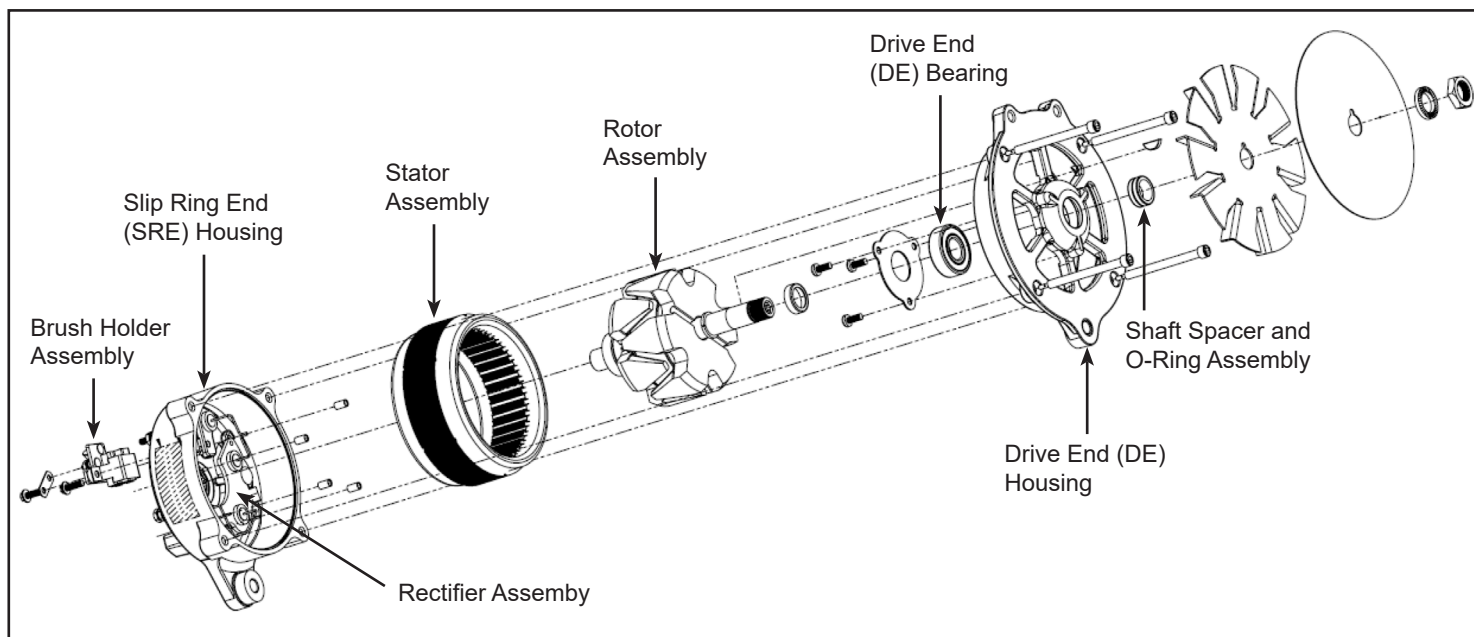


Figure 2.12 - Alternator Exploded View (typical)

2.5 Theory of Operation

- A. Power to drive the alternator is derived from the aircraft powerplant by means of a belt for belt-driven type alternators and by means of a gear for direct-driven type alternators. Torque is transmitted through the drive to the alternator rotor shaft resulting in rotor rotation.
- B. During operation, the F1 terminal is electrically excited by an external voltage regulator. The F2 terminal is either electrically connected to the SRE housing (ground) internal to the alternator, externally at the alternator, or remotely by means of the aircraft electrical system. As current flows through the rotor coil a magnetic field is created with lines of flux being concentrated between the pole-shoe fingers. As the rotor turns these lines of flux are swept over the stationary stator coil windings inducing an alternating current flow within them. This three-phase alternating current is conducted to the bridge rectifier circuit which converts the alternating current to direct current. This rectified, DC current is made available to external loads via the +B terminal.

2.6 Self Excitation Description

- A. The HET alternator model ES-10024B-5 (-5LS), when used in conjunction with an ACU (alternator control unit) that is designed to “boot strap” field voltage during low speed operation, has the ability to self-excite. In other words, the alternator/ACU system has the ability to generate power, even in the absence of battery voltage, i.e. in “batteryless” systems, or those in which the battery is not always connected to the alternator.
- B. Self-excitation ability derives from residual magnetism in the rotor pole pieces. A minimum generated voltage is necessary to power the ACU and begin normal alternator regulation. Self-excitation is available only on the ES-10024B-5 and -5LS.

2.7 Operational Data

Alternator Model	ES-10024	ALV-9610	ES-10024B	ES-6024D
Drive Type	Direct	Direct	Belt	Direct
Cooling	Through-flow	Through-flow	Fan, External	Through-flow
N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A
Min Regulation Speed	2,200 RPM	2,200 RPM	2,200 RPM	1,800 RPM
Max Continuous Speed	10,000 RPM	10,000 RPM	10,000 RPM	10,000 RPM
Voltage, Bus	24 volt	24 volt	24 volt	24 volt
Voltage, Rated	28 volt	28 volt	28 volt	28 volt
Current, Rated	100 Amp	100 Amp	100 Amp	60 Amp
Rated Altitude (feet)	31,900 feet MSL	31,900 feet MSL	31,900 feet MSL	31,900 feet MSL
Rated Altitude (meter)	9,723 meters MSL	9,723 meters MSL	9,723 meters MSL	9,723 meters MSL
Weight (lbs / kgs)	12.6 lbs (5.72 kgs)	12.6 lbs (5.72 kgs)	12.75 lbs (5.78 kgs)	11.5 lbs (5.22 kgs)
Field Type	(F1)	(F1 & F2)	(F1 & F2)	(F1 & F2)
Filter Type	Capacitor; .50 μ F Δ	N/A	Capacitor; .50 μ F * Δ	Capacitor; .50 μ F Δ
Field Resistance	6.5-7.5 ohm 25° C	6.5-7.5 ohm 25° C	6.5-7.5 ohm 25° C	14.9-15.4 ohm 25° C
Belt Tension, Max	N/A	N/A	See Table 6.2	N/A

Table 2.1 - Operational Specifications

* ES-10024B-5 & ES-10024B-5LS do not contain an internal filter assembly.

Δ Early models may have an internal PCB with gas-discharge-tube and capacitor (.47 μ F).

CHAPTER 3 - TROUBLESHOOTING

3.1 General

- A. In the event of malfunction in electrical power, it should not be assumed to be an alternator fault before employing proper troubleshooting procedures. The overall objective of trouble-shooting is to find the cause of trouble and take corrective action to prevent a recurrence. Even perfectly operational alternators cannot compensate for improper adjustments, corroded or worn parts, and improper installation or lack of maintenance.
- B. This section provides general troubleshooting procedures for the alternator assembly for unscheduled maintenance and for possible fault detection prior to maintenance activity. It gives procedures to follow to determine the best course of action prior to disassembly. Block type troubleshooting charts are also provided. Upon determination of fault(s), refer to the TESTING (section 6) for applicable test procedure(s).

3.2 Procedure

WARNING



WHEN SERVICING, REPAIRING, OR OVERHAULING THE ALTERNATOR, GREAT CARE AND CAUTION MUST BE TAKEN TO AVOID HAZARDOUS SITUATIONS. THE ALTERNATOR WHEN MOUNTED ON AN AIRCRAFT OR ROTORCRAFT, PRESENT A PHYSICAL HAZARD FROM PROPELLERS, ROTORS AND OTHER ROTATING DEVICES. THE ALTERNATOR PRODUCES A HIGH ELECTRICAL CURRENT OUTPUT AND ALSO PRESENTS AN ELECTRICAL SHOCK HAZARD, THAT CAN RESULT IN SERIOUS INJURY IF PROCEDURES IN THIS MANUAL OR THE AIRCRAFT/ROTORCRAFT SERVICE MANUALS ARE NOT FOLLOWED.

Note:

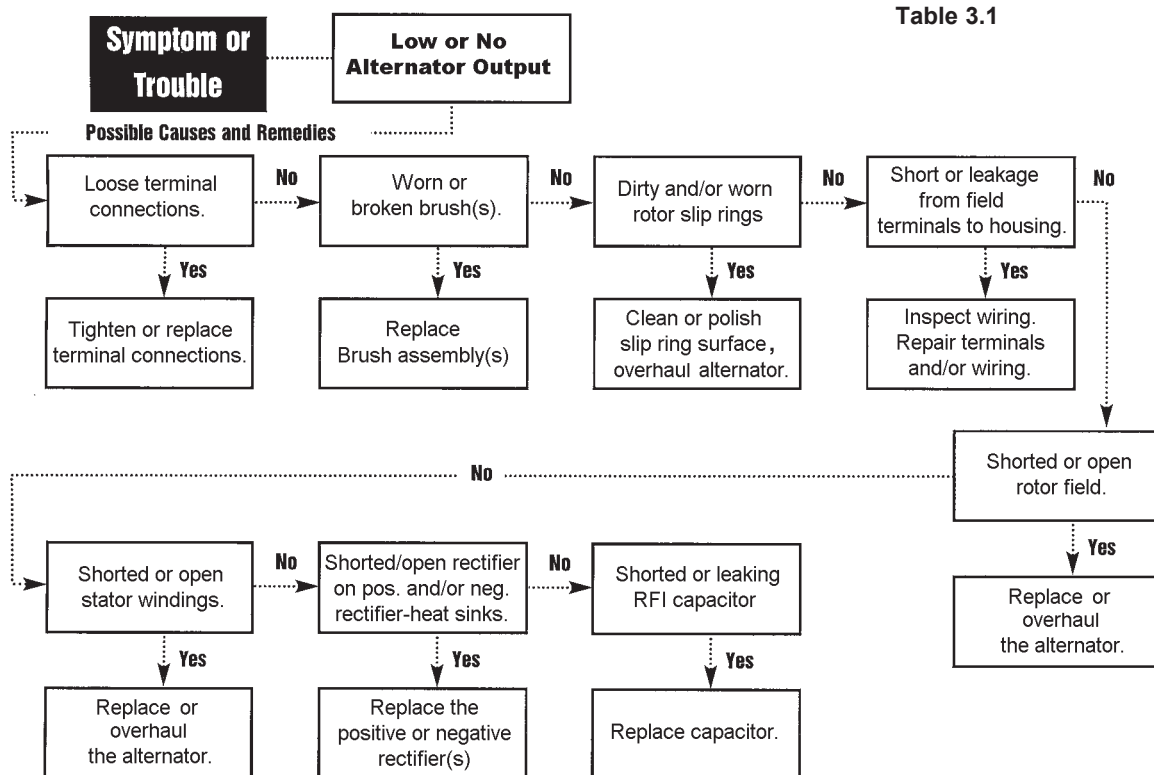
It is required to reference the aircraft or rotorcraft AFM or POH as well as the applicable service or maintenance manual as required.

- A. The Charts on the following pages represent six main areas of trouble in an alternator. Choose the applicable symptom and follow the trouble shooting chart flow. Below each chart is a discussion of each point.

- 3.1. Low or No Output.
- 3.2. Battery is Discharged.
- 3.3. Battery is Overcharged.
- 3.4. Noisy in Operation (mechanical).
- 3.5. Noisy in Operation (electrical).
- 3.6. Ammeter or Lights Flicker.

3.2 Continued

Troubleshooting - Low/No Alternator Output



Loose terminal connections: Inspect the terminals, if they will tighten, do so, if not the alternator may need to be disassembled to replace studs or receptacles. Also observe the wire terminal ends to assure they are crimped properly on the wire with no corrosion or burns present. If disassembly is required, replace or overhaul alternator.

Worn or broken brushes: Remove and examine brush material, spring, and leads. If spring is broken or the lead is coming out of brush, or if brush is chipped or worn past 50% replace brush.

Dirty or worn rotor slip rings: If dirty, the slip rings may be cleaned. Take care not to scratch the surface. If the slip rings are worn beyond limits, replace or overhaul alternator (see section 6).

Short or leakage from field terminals to housing: Unless it is determined the wire terminal is shorting to the housing, replace the field terminals and insulators. If disassembly is required, replace or overhaul alternator.

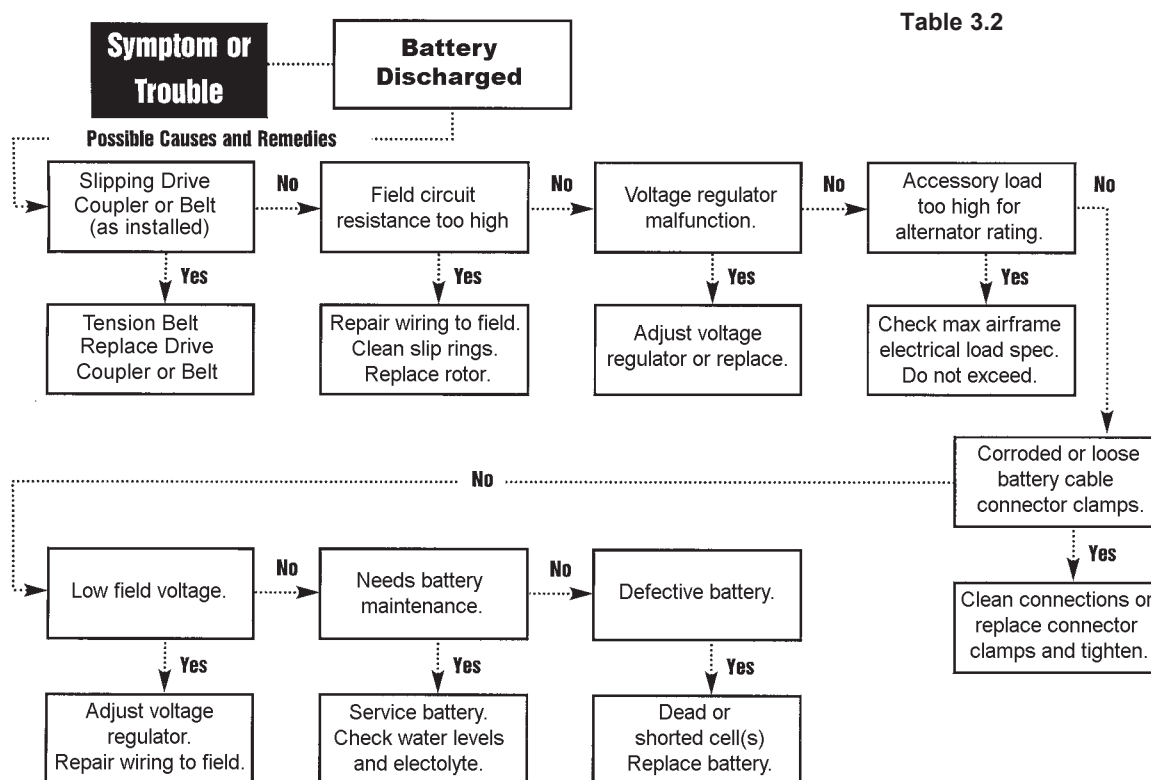
Shorted or open rotor field: Perform the tests for rotors as found in section 6. Rotor removal may be required to verify the symptom. Replace or overhaul alternator (no repairs allowed on rotors).

Shorted or open stator windings: Perform the alternator tests found in section 6. Stator removal may be required to verify the symptom. Replace or overhaul alternator if failed (no repairs allowed on stators).

Shorted or open rectifier on heat sinks: Perform the tests for rectifiers (positive and negative) as found in section 6. Disassembly may be required to verify symptom. Replace or overhaul alternator.

3.2 Continued

Troubleshooting - Battery Discharged



Shorted or leaking RFI capacitor (airframe, engine, HET external filter): Remove capacitor and perform capacitance check and wire lead to case resistance check. Replace filter capacitor if failed (external filter only). If an internal PCB type filter, replace or overhaul alternator if failed. **Drive coupler slipping:** Inspect the condition of the drive clutch. (as applicable) This part is supplied by the engine manufacturer. Improper tension supplied by this clutch will allow slippage during high alternator output.

Drive Belt slipping: Inspect the condition of the pulley belt. (as applicable) The belt is supplied by the engine manufacturer. Improper tension supplied on the belt may allow slippage during high alternator output.

Field circuit resistance too high: Check wiring and terminal ends and repair as necessary. Check condition of the slip rings and clean. Check rotors as found in section 6 and if failed, replace or overhaul alternator.

Voltage regulator malfunction: Check the voltage regulator per the aircraft service manual and adjust if necessary. If adjustment is not possible, check wiring and replace voltage regulator.

Accessory load too high for alternator rating: Refer to the AFM or POH (and aircraft service manual) for the maximum allowable load specification. Reduce electrical load to meet these limitations.

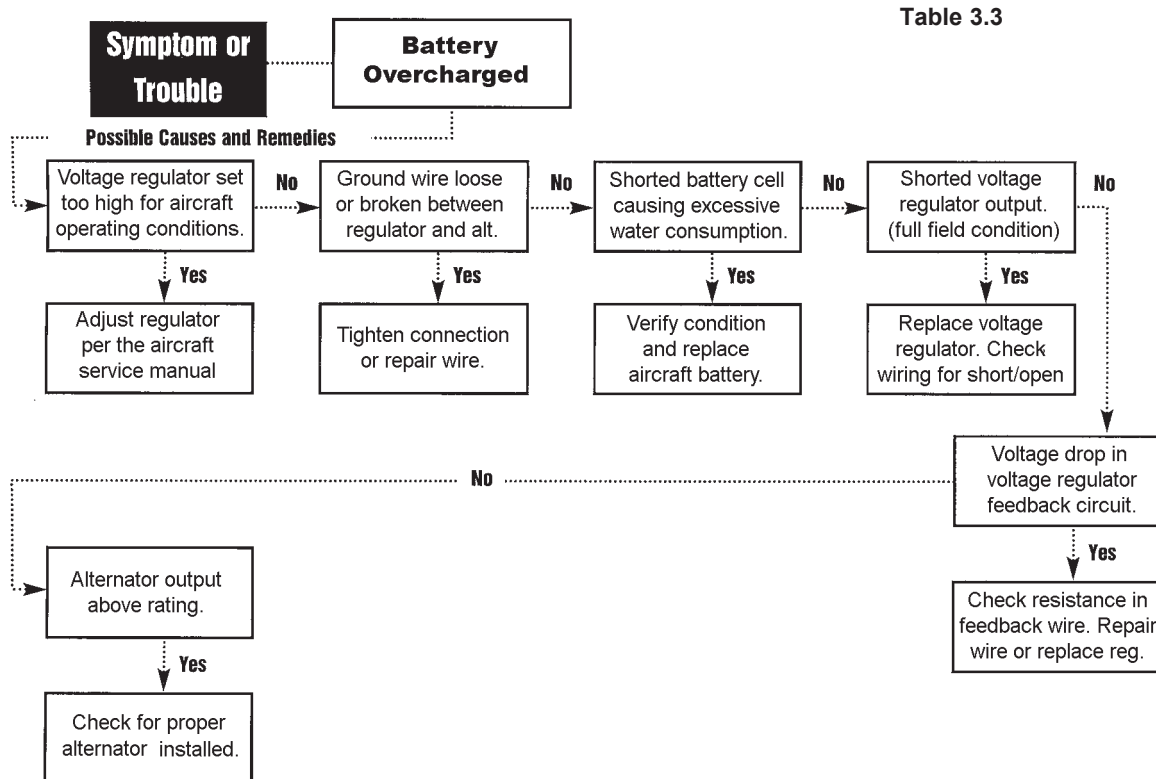
Corroded or loose battery cable connector clamps: If connections to the battery are corroded, disconnect and clean. Clean battery posts or terminals. If aluminum cable is installed, make sure that corrosion has not spread under the insulation. If severe, replace cables or clamps. Tighten battery connections.

Low field voltage: Check the voltage regulator per the aircraft service manual and adjust if necessary. If adjustment is not possible, check wiring and replace voltage regulator.

Needs battery maintenance: Perform normal battery maintenance. Check water level and electrolyte condition, service per the aircraft service manual.

3.2 Continued

Troubleshooting - Battery Overcharged



Failed battery: Determine battery age and check for expected life. If near or beyond normal life, replace battery. If battery discharges frequently, check for dead or shorted cells, if found replace battery. **Voltage regulator set too high for aircraft operating conditions:** Check the voltage regulator setting per the aircraft service manual. Adjust if necessary. If adjustment is not possible, check the wiring harness before replacing the voltage regulator.

Ground wire loose or broken between regulator and alternator: If wire is broken, make sure there is adequate strain relief and clear chaffing areas. Repair or replace wire. If loose, tighten connection.

Shorted cell in battery causing other cells to use water excessively: Remove and place battery on battery tester to verify the condition. Replace failed battery.

Shorted voltage regulator output - full field condition: Before replacing the voltage regulator, check wiring harness for shorts or open conditions. If harness is burnt or shows signs of overheating, replace harness. If wiring is good replace voltage regulator.

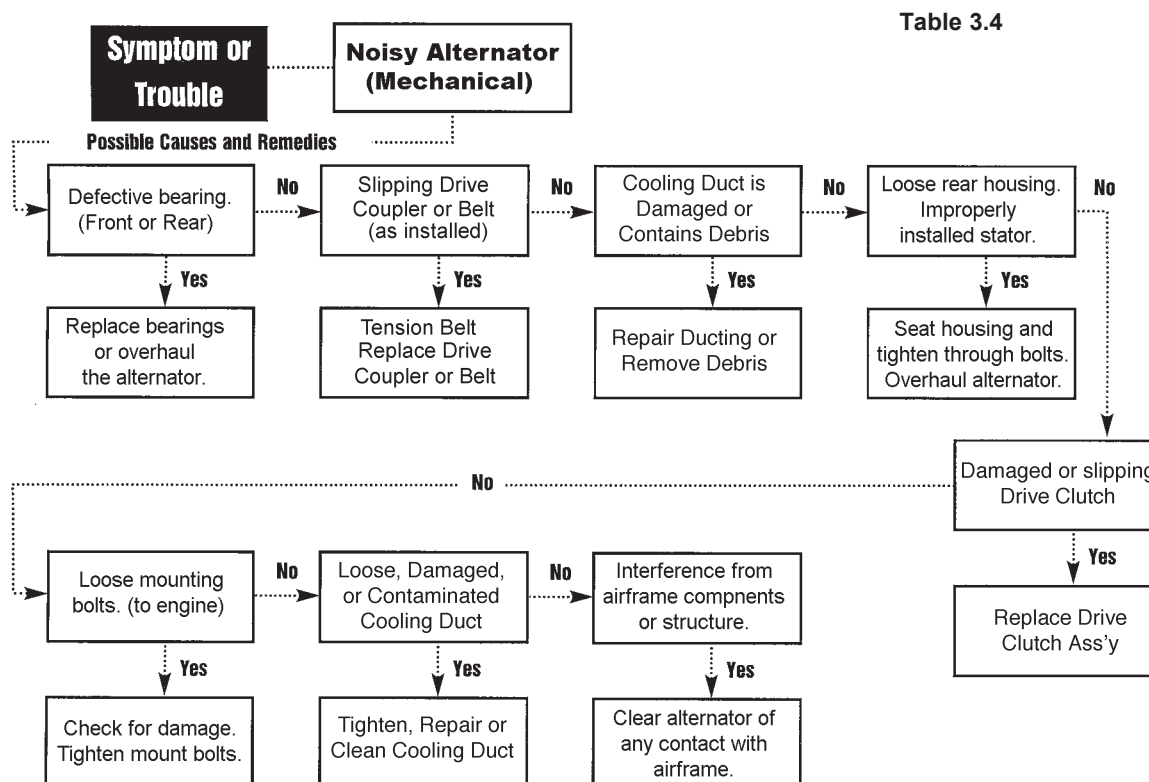
Voltage drop in voltage regulator feedback circuit: The “feedback” line is commonly known as the sense line. Before replacing the voltage regulator, check sense line wire for resistive or short conditions. Check terminal connections, replace or repair wire if bad. If wiring is good replace voltage regulator.

Alternator output above rating: As output is related to alternator speed, check that the proper alternator has been installed. Check airplane records to determine that the proper alternator model and rating is installed per the aircraft TC or STC.

Failed bearing: To perform a test for failed bearings, hold the alternator in one hand and snap-spin the shaft with the other. A failed bearing will be heard or felt. Replace the bearing by overhaul or replacement of the alternator.

3.2 Continued

Troubleshooting - Noisy Alternator



Drive coupler slipping: Inspect the condition of the drive clutch. (as applicable) This part is supplied by the engine manufacturer. Improper tension supplied by this clutch will allow slippage during high alternator output.

Drive Belt slipping: Inspect the condition of the pulley belt. (as applicable) The belt is supplied by the engine manufacturer. Improper tension supplied on the belt may allow slippage during high alternator output.

Foreign object in cooling duct: Check the duct length and the inlet of the alternator to see if debris have entered the alternator and are rubbing internally or vibrating in the duct.

Loose rear housing or improperly installed stator: Examine through bolts, if loose and distorted or severe “smoking” or black areas appear at the head of the bolt, the alternator should be overhauled or replaced.

Loose mounting bolts: Inspect mount points for damage and if found overhaul the alternator. If not, re-torque mounting bolts per the engine or aircraft service manual.

Loose cooling duct connection: If cooling duct is installed improperly (normally an airframe component), adjust and tighten the mounting connection (as applicable). Check and clear any interference with the airframe structure.

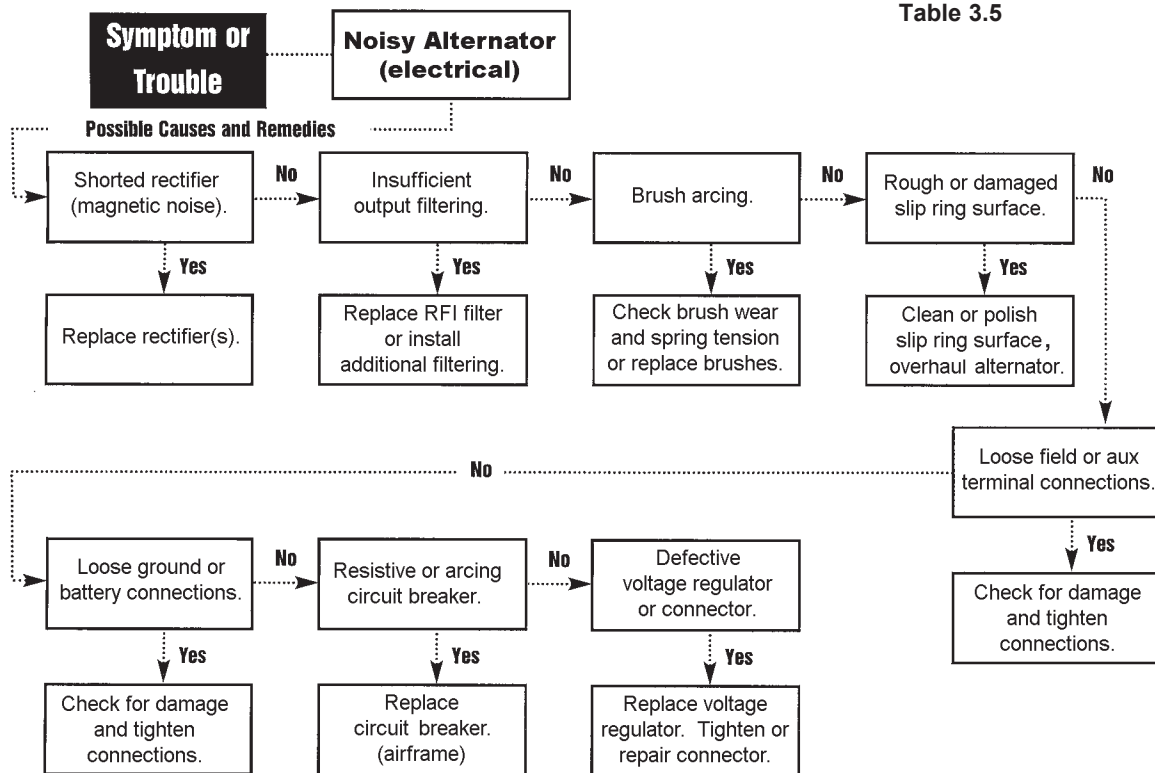
Interference from airframe components or structure: Examine the alternator and large electrical cables for contact or chaffing on airframe structure. Check and clear any interference areas.

Shorted rectifier (magnetic noise): Perform the tests for rectifiers as found in section 6. Disassembly may be required to verify symptom. Replace or overhaul alternator.

Insufficient output filtering: Check the RFI filter by performing a capacitance check. Replace RFI filter if failed (external filter only). If an internal PCB type filter, replace or overhaul alternator if failed. In some cases, additional RFI filters may be installed, be sure that a check is performed on each. If only one RFI filter is installed, additional filters may be required to reduce noise.

3.2 Continued

Troubleshooting - Noisy Alternator



Brush arcing: Remove and examine brush material, spring, and leads. If spring is broken or the lead is coming out of brush, or if brush is chipped or worn past 50% replace brush. Examine slip ring surface for condition.

Rough or damaged slip ring surface: If the slip rings show minor surface roughness they may be polished. If the slip rings are worn or damaged beyond limits, replace or overhaul alternator (see section 6).

Loose field or aux terminal connections: Check terminal connections for damage. Provide adequate strain relief to the wiring and tighten terminals properly.

Loose ground or battery connections: Check ground and battery connections for damage. Provide adequate strain relief to the cables and tighten properly. (See engine or aircraft service manuals.)

Resistive or arcing circuit breaker: Make a resistance check of the circuit breaker, essentially, there should be no resistance. Check breaker function. Old circuit breakers should be replaced.

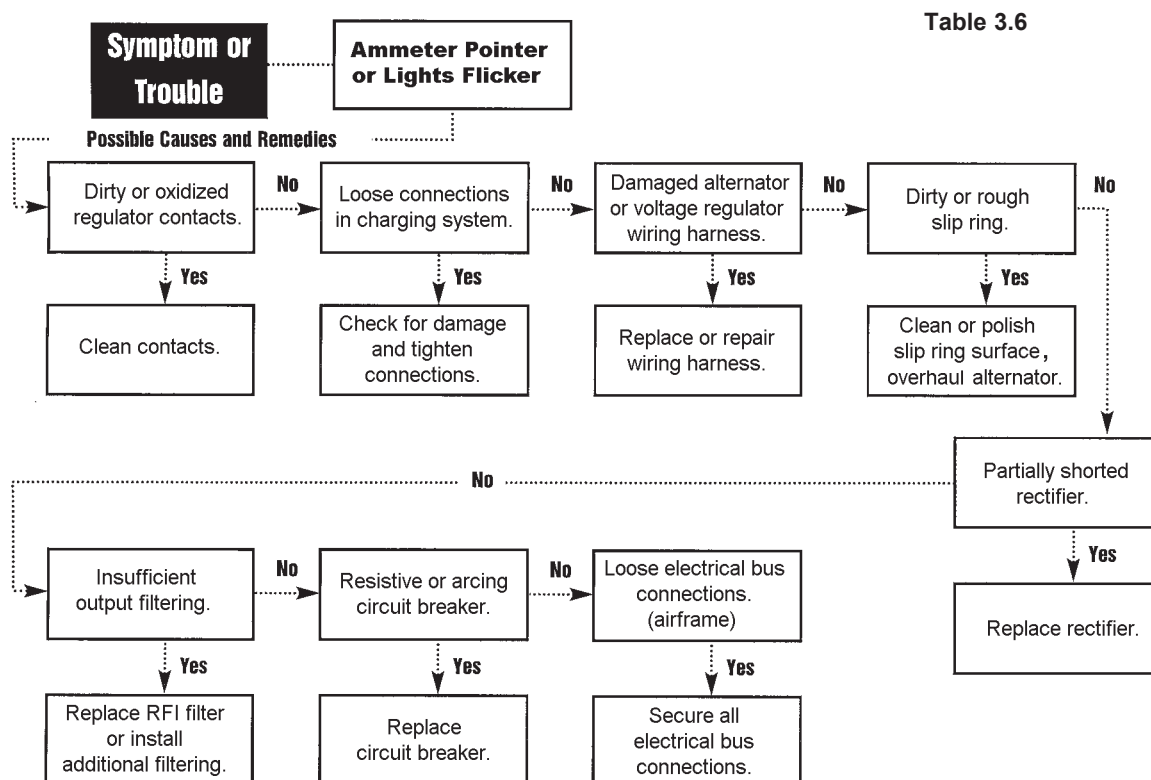
Failed voltage regulator or connector: Check to see if the regulator connector is attached properly. Remove and examine connector. Look for arcing or overheating. Check wiring harness and replace the voltage regulator if failed.

Dirty or oxidized regulator contacts: Inspect both the male and female connector contacts. Clean using an aviation quality contact cleaner. For circuit board edge contacts, first use a pencil eraser on the edge followed by contact spray cleaner.

Loose connections in charging system or damaged wiring harness: Inspect the terminals, if they will tighten, do so. Also observe the wire terminal ends to assure they are crimped properly on the wire and no corrosion or burns are present. Check harness from end to end and repair any damaged wiring.

3.2 Continued

Troubleshooting - Ammeter Pointer or Lights Flicker



Damaged alternator or voltage regulator wiring harness: Check wiring harness for damage and repair. If damage is found, check voltage regulator for function and replace if necessary.

Dirty or rough rotor slip rings: If dirty, the slip rings may be cleaned. Take care not to scratch the surface. If the slip rings are worn beyond limits, replace or overhaul alternator (see section 6).

Partially shorted rectifier: Perform the tests for rectifiers as found in section 6. Disassembly may be required to verify symptom. Replace or overhaul alternator.

Insufficient output filtering: Check the RFI filter by performing a capacitance check. Replace RFI filter if failed (external filter only). If an internal PCB type filter, replace or overhaul alternator if failed. In some cases, additional RFI filters may be installed, be sure that a check is performed on each. If only one RFI filter is installed, additional filters may be required to reduce noise.

Resistive or arcing circuit breaker: Make a resistance check of the circuit breaker, essentially, there should be no resistance. Check breaker function. Old circuit breakers should be replaced.

Loose electrical bus connections: Check aircraft electrical bus for loose wire connections. Tighten or repair as required.

3.3 Alternator Drive Coupling Troubleshooting

- A. The alternator drive coupling is provided by the airframe or engine manufacturer and those manufacturers normally issue instructions regarding maintenance and installation. The alternator drive coupling is fundamental to the operation of Hartzell Engine Technologies (HET) gear driven alternator. Observe the following information when installing and using the drive coupling:
- B. If an alternator is determined to be at fault, note that the gear coupling is considered a part of the engine installation and should be removed from the alternator and properly installed on the replacement unit.
 - (1) Check for any and all service information from the engine, airframe and the drive coupling manufacturer concerning the installation, inspection, and replacement of the drive coupling.
 - (2) Check the general condition of the drive coupling (this requires removal of the alternator).
 - (3) Check the shaft nut and cotter pin for damage. (Damage to these parts will indicate interference with internal engine parts.) If damaged, determine cause and correct the issue.
 - (4) Using the manufacturer's service information, check the condition of the gear teeth and the elastomer insert. If damaged, replace or overhaul the drive coupling.
 - (5) Whenever the alternator is overhauled, HET recommends that the drive coupling be replaced. If the alternator cannot be overhauled or repaired and is being replaced, the coupling should also be replaced.
 - (6) To further aid inspection, Continental Motors includes drive coupling service information in the appropriate engine manuals and also in service bulletins. (Refer to CMI SB11-3 and/or SB95-3B for drive coupling service information.)

3.4 Alternator Belt Troubleshooting

- A. Although the alternator belt is provided by the airframe or engine manufacturer and those manufacturers normally issue manuals or instructions regarding their maintenance, the belt is fundamental to the operation of Hartzell Engine Technologies LLC (HET) alternator. As such, some general troubleshooting regarding the belt is offered here to prevent mis-diagnosis of what may seem to be an alternator fault.
- B. Hartzell Engine Technologies new or overhauled alternators using belt drives are designed for two basic types of belts via custom pulley installations. The most common type is the single smooth V belt (large and small width) and the Poly-V belt type which has multi-V groves but is nearly flat. The basic function of these belts (either type) is to transfer rotational energy produced by the engine to various accessories that are needed for the aircraft.
- C. The belt system or "drive" may be simple, running from the engine drive sheave to an alternator or it might be complex in not only running the alternator, but including the A/C compressor, hydraulic pump, or idler pulleys. Belt drives are efficient and safe. However, the more complex, the more difficult it is to align the "drive". This troubleshooting will provide insight into both sound and visual inspection practices to identify a belt condition before moving on to the alternator or other component.

3.4 Continued

- D. If an alternator is determined to be at fault, note that HET sells alternators with or without a pulley due to the desire of engine and airframe manufacturers to sometimes use their own custom pulley and belt arrangements. The HET alternator designated ES10024B-1 is delivered without a pulley. Other HET ES10024B series alternators are delivered with varied size and type pulleys.
- E. Unusual belt condition, low belt tension, belt contamination, and belt vibration are other sources of belt noise. A screech or squeal that occurs when starting or increasing engine RPM rapidly typically indicates a lack of tension so check belt tension. A tapping or grinding sound caused by debris imbedded in the drive side of the belt can be the cause and should be checked. Grinding noise can result from worn or damaged bearings which must be replaced (overhaul or replace alternator). This will eliminate the bearing noise and possible damage to the alternator. Mechanical noise from vibration can develop over time as drive components such as pulleys and spring tensioners (if used) wear beyond tolerance, as bearings wear, or as belts wear and stretch allowing brackets and attachments to loosen.
- F. Specific belt noises may give clues to misalignment conditions. Noises can occur in both single V type and Poly-V type belts. The belt is less likely to generate misalignment noise when in new condition. As a belt wears, it will develop a smooth, glossy surface which will increase the possibility of noise. A wear condition will be accelerated if misalignment exists between any of the pulleys in the drive system.
- G. A drive misalignment will make a “Chirp” noise in both the common V belt and the flat Poly-V belt. This is caused by entry of the belt contact surface into the pulley as the V(s) seat into the pulley groove there will be a chirp that is not repeated as the belt exits. The angle between belt surface and pulley is the critical factor responsible for causing the “chirp” from a misalignment. Misalignment angle can result from many different combinations of pulley positions. An in or out “positioning” error and/or an angular “tilting” error are two typical examples.
- H. Misalignment noise is most likely to occur on the shortest span in a drive system, such as between two adjacent accessory pulleys. Proper pulley alignment is particularly critical in these locations. The common V belt pulley has a generally large groove while the nearly flat multi-groove pulley has very small grooves guiding the belt both can have considerable misalignment and create the same noises.
- I. Misalignment noise is generally loudest at idle speed and diminishes with increasing engine rpm, often vanishing higher RPM's. The presence of high humidity (or a wet belt) often increases the likelihood for misalignment noise to occur.

3.4 Continued

- J. Whenever the pilot notes belt noise, it is important to determine the type of noise and under what circumstances it occurs. Repairing a drive misalignment (chirp) is not likely to resolve a slip noise (squeal) that may be caused by insufficient tension.
- (1) Check if the problem is more noticeable when starting and while the engine is cool (cool wet belt).
 - (2) Is the noise loudest at idle speed, or when accelerating the engine RPM (rapid changes in RPM speed can cause a belt to slip).
 - (3) Try to recreate the problem in the maintenance run area. If the noise is heard, use a spray bottle or other source of misting water and mist the belt lightly. If the noise level recedes or goes away for several seconds, then returns, the problem is most likely misalignment.
 - (4) If the noise immediately increases after the belt is sprayed, slipping is likely.
 - (5) If the water spray test is inconclusive and the noise remains unchanged, the problem is not likely related to drive alignment.

CHAPTER 4 - CHECK

4.1 General

- A. This section defines the various checks and inspections needed to assure reliable and safe operation of the alternator while in service. They are listed in hours time in service (TIS) or in calendar time, whichever is applicable and are the first to occur when offered a choice. Some maintenance is one time initial and others are recurring.
- B. HET recommended maintenance and checks including TIS may be superseded by the aircraft or engine manufacturer's established time limits and schedules based on experience and/or unique requirements under engine or airframe Type Certificate.

4.2 Inspection Checks

100 Hours TIS & each 100 hours thereafter. (or each annual/event, the first to occur)

Perform a check of the alternator assembly. Note through bolt security and proper safety wire application. Re-torque if bolts are found loose. Check the alternator to engine mounting bolts for proper torque per aircraft, rotorcraft and/or engine service instructions or maintenance manual. Inspect area around the brush holder for soot. If a large amount of soot appears, remove each brush and check for wear or damaged brushes. If severe wear has occurred, check slip rings for gouges or scratches. Check all terminal hardware for tightness and insulators for condition.

500 Hours TIS & each 500 hours thereafter. (or each two years, the first to occur)

Remove each brush and check for wear or damaged brushes. If brush shows more than 50% wear or has chips or damage, replace brushes (brushes must be replaced as a set only). New brushes are 0.50 inch (12.7 mm) long. With the alternator removed, check the drive coupling or visually check belt and belt drive line components. Adjust belt tension to proper values per engine/aircraft service instructions or maintenance manual. Examine the alternator insulators and replace if cracked or burnt. Inspect the aluminum housing for surface corrosion, clean and treat. Inspect housings for cracks around through bolt holes and ears.

TBO Unlimited Hours TIS

Overhaul or replacement is based on the condition of the alternator. *Overhaul time may vary based on cooling, electrical load and general service. When published, the aircraft OEM TBO shall supersede this HET recommendation.*

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CHAPTER 5 - INSPECTION & TESTING

5.1 General

This chapter outlines the tests and inspections required to determine the condition of the alternator removed for scheduled and unscheduled maintenance. Refer to the procedures given in the TROUBLESHOOTING Chapter prior to applying any test for maintenance.

Where applicable, components called out this section will correspond to the item number listed in Chapter 6, MAINTENANCE.

A. Equipment

(1) Standard tools

- Standard mechanic's handtools.
- Torque wrench ounce-inch (gram-centimeter).
- Torque wrench pound-foot (newton-meter).
- Safety gloves.
- Protective goggles (eye protection).
- Ear Plugs (hearing protection).
- Safety shoes.
- Protective cotton apron.
- Air compressor (shop air).

(2) Special tools

The following are only required if alternator was removed for bench testing

- Alternator test bench (see Fig. 5.2)
- 24v aircraft battery
- Pulley (optional, see Fig. 5.1)
- Belt tension gauge, universal
- Alternator mounting fixture (5.3)

(3) Instruments

- A multimeter, (Simpson 260 or Triplet 630) or equivalent (accuracy 1%)
- An Oscilloscope x100, x1000 range. (optional)
- Alternator test meter, Amtest Model 648 (optional)
- Optical tachometer (optional)
- Variable DC load bank (3kW minimum)

B. Precautions

Regular maintenance must be accomplished per this manual and per the applicable aircraft and/or engine service manuals and publications. In addition, observe the following precautions:

- (1) DISCONNECT THE BATTERY before connecting or disconnecting test instruments (except voltmeter), or before removing or replacing any unit or wiring. Accidental grounding or shorting at the regulator, alternator, ammeter or accessories, will cause severe damage to the units and/or wiring.
- (2) DO NOT REMOVE THE OUTPUT LEAD. The output lead must not be removed from the alternator while the rotor winding is energized and the alternator is operating.
- (3) DO NOT ATTEMPT TO POLARIZE THE ALTERNATOR. For alternator model ES-10024B-5 or -5LS, refer to section 5.4 for "Alternator Self Excitation Test".
- (4) DO NOT GROUND THE OUTPUT TERMINAL. Grounding of the alternator output terminal may damage the alternator and/or aircraft electrical circuit.
- (5) DO NOT REVERSE BATTERY CONNECTIONS. Reversed battery connections may damage the rectifiers, aircraft wiring or other components of the charging system. Battery polarity should be checked with a voltmeter before connecting the battery.
- (6) ASSURE PROPER CONNECTIONS TO THE BATTERY. If a booster-battery or fast-charger is used, its polarity must be connected correctly to prevent damage to the electrical system components.

5.2 Inspection**A. Arc Marks on Terminals (Visual Inspection):**

- (1) Before removing the alternator, the threads and each terminal stud should be inspected for signs of arcing.
- (2) Arc marks are usually caused by a loose wire terminal connection resulting from failure to tighten the attaching nut.
- (3) Arc marks can also be caused by improper service techniques that permit wires to be connected and disconnected while current is flowing. A loose connection at the alternator output (battery) terminal can erode completely through the terminal stud over time.
- (4) Diode damage can occur because of the inductive voltage spikes generated by the make and break of loose terminal connections. The positive and negative rectifiers must be replaced at next alternator overhaul.
- (5) Voltage regulator and mechanical field relay damage can also be expected due to the chattering contacts each time the loose connection makes or breaks. Chattering contacts that are excessive will result in rapid contact erosion.
- (6) Solid state field relays will not be damaged, however they may generate electrical noise.

B. Bearing Inspection (For Troubleshooting Purposes):

- (1) A simple bearing test should be performed regardless of the reason for alternator removal from the engine. This may be done on or off the engine. The purpose of the test is to determine if either of the bearings are a potential for noise or failure.
- (2) To perform a test for worn bearings, disengage the belt or hold the alternator in one hand and snap-spin the shaft/pulley with the other. A worn bearing will be heard or felt. Snap-spin the shaft/pulley a few times to verify.

- (3) Grasp the drive component (pulley or coupling) and push-pull the shaft in a direction parallel to the axis. Movement should be small, less than .0062 inch (.1575 mm).
- (4) Grasp the drive component (pulley or coupling) and push-pull the shaft in a direction perpendicular to the axis. Movement should be small, less than .001 inch (.025 mm).
- (5) If either bearing sounds noisy, movement is not smooth, or excessive movement (axial or radial) is observed, the alternator should be sent for repair, overhaul, or replacement.

C. Field Circuit Open or Ground Test Procedure:

- (1) Using a multimeter on low range scale (0 to 25 ohm), connect one lead of ohmmeter to the "F1" terminal and the other lead to "F2" terminal or ground depending on the model being tested.
- (2) Spin the output shaft and note ohmmeter reading. Meter should read between 7 and 20 ohms while rotor is turning.
- (3) A reading lower than 3.5 ohms indicates either a grounded field terminal or a failed rotor. Repair field or send alternator for repair, overhaul, or replacement.
- (4) A reading higher than 20 ohms indicates: either worn out or hung brushes, an open brush lead or a failed rotor.
- (5) Items (2) and (3) reading may be addressed by replacement of the brushes or the brush holder assembly. Refer to section 6.7 (Maintenance) for brushes.
- (6) Item (3 & 4) failed rotor requires overhaul or replacement of the alternator.

D. Mounting Hardware:

- (1) Inspect and replace any removed metallic hardware, i.e., screws, flat washers, nuts, shaft spacer, shaft woodruff key, etc., exhibiting damage, wear, corrosion, or distortion.
- (2) Hardware that will be reused shall be cleaned as required, using a non-corrosive chemical degreaser. Air-dry parts with filtered dry low pressure compressed air or wipe dry with clean, lint free cloth.

E. Insulators (Washers and Spacers):

- (1) Inspect parts for cracks, deformation, and burn marks.
- (2) Parts that are suitable for reuse shall be cleaned as required using isopropyl alcohol. Any other cleaner may damage insulators. Air-dry parts with filtered dry low pressure compressed air or wipe dry with clean, lint free cloth.
- (3) Cracked or faulty insulators require replacement or overhaul of the alternator as it must be disassembled to replace damaged parts.

F. Brush holder, Brushes and Springs:

- (1) Inspect brush holder for cracks or breaks and brushes for condition.
- (2) If damaged, discard the brush holder assembly and replace with new.
- (3) If brushes are worn or damaged in any way, replace brushes in pairs with new. Never attempt to replace a single brush.
- (4) New brushes are 0.50 inch (12.7 mm) long and must be replaced at 50% wear.

G. Pulley Run Out Check:

Note: A pulley runout check must be done with the pulley installed on the alternator. Consult the aircraft and/or engine maintenance manuals for procedures to perform the pulley runout check while on the aircraft engine. Do Not install alternator belt prior to checking pulley runout.

- (1) Place the alternator in a secure fixture but take care not to damage the alternator body using a vice or similar holding device. (May also be checked while mounted on the aircraft engine with belt removed if space permits.)
- (2) Install a dial indicator set up with the indicator measuring on the front face of the installed pulley. Indicator must be capable of measuring 0.0005 inch or better.
- (3) Install a dial indicator set up with the indicator measuring on the groove edge of the installed pulley. Indicator must be capable of measuring 0.0005 inch or better.
- (4) Zero out the indicator and slowly rotate the pulley for each axis runout check.
 - (a) All ES10024B series pulley assemblies except that of the ES10024B-5 must not exceed a runout of 0.008 inch on either axis.
 - (b) The ES10024B-5 alternator (HET P/N 40840 pulley) must not exceed a runout of 0.006 inch on either axis.

5.3 Alternator Bench Testing**CAUTION**

BEFORE BEGINNING THESE PROCEDURES, REFER TO AND OBSERVE THE PRECAUTIONS LISTED ON PAGE 5-2 OF THIS SECTION. BENCH TEST PROCEDURES MUST BE PERFORMED BY AN APPROPRIATELY RATED MECHANIC IN AN ADEQUATELY EQUIPPED FACILITY.

A. Alternator Output Test Conditions

- (1) The alternator is to be at room temperature (70-80 degrees Fahrenheit or 21-27 degrees Celsius) before beginning the test.
- (2) The alternator is to be connected so that it is supplying its own field current.
- (3) The output is to be controlled by an adjustable load.
- (4) The alternator is not to be run for longer than 30 seconds for each test point.

B. Ventilation

- (1) Alternators not equipped with an external fan are cooled entirely by air pressure supplied to a SRE air inlet. When bench testing this type of alternator, testing should be performed as short as possible unless adequate air pressure for cooling is supplied. Adequate air pressure should be applied across the unit and is considered to be at least 3" H₂O delta pressure.

C. Order of Tests

- (1) To minimize the affects of heat, it is recommended to test the alternator at the highest RPM rating first (see Tables 5.1 thru 5.3).

D. Test Setup

- (1) For gear driven alternators, install a fabricated test pulley (Fig. 5.1), washer, and nut onto the alternator shaft. All ES-10024B models shall be tested with the original manufacturer installed pulley.
- (2) If testing a gear driven alternator, torque nut to 30 ft-lbs max to secure the fabricated test pulley.
- (3) Mount the alternator to a test bench that is capable of turning the rotor shaft 10,000 RPM in combination with drive pulley and alternator pulley. See Fig. 5.2 for typical test bench setup.
- (4) Apply 50-80 lbs. of tension to drive belt and check for belt slippage. If the belt slips, increase tension in 10 pound increments, not to exceed 120 lbs. Check drive belt tension with a belt tension gauge. Do not exceed maximum belt tension in Table 6.2 for belt driven alternators.
- (5) Make electrical connections as shown in Figures 5.4 and 5.5.

WARNING



TO PREVENT PERSONAL INJURY AND OR COMPONENT DAMAGE FROM ARCING, HOOK THE BATTERY TO THE SYSTEM ONLY AFTER ALL OTHER CONNECTIONS ARE MADE.

NOTE: It is recommended to use a switched jumper from the F1 terminal to the DC output terminal. Once the battery is connected, F1 is energized and has potential to drain the battery. It is recommended to leave the jumper open until ready to test the alternator.

- (6) Close the circuit between the DC output terminal and the F1 terminal. This will energize the field (F1).
- (7) Run Tests #1 thru #3 (Table 5-1): At each speed point, adjust the variable DC load bank to obtain the specified voltage.

CAUTION:



ALL GEAR DRIVEN ALTERNATORS REQUIRE A SOURCE OF VENTILATION. DO NOT TEST THESE ALTERNATORS AT FULL RATED OUTPUT FOR MORE THAN 30 SECONDS.

- (8) Once the alternator passes all tests, remove the alternator from the test bench.
- (9) Remove nut, washer, and pulley from the alternator.
- (10) For gear driven alternators, inspect the rotor shaft (13) threads and O-ring (2) for damage, repair or replace if damage is noted.
- (11) For belt driven alternators, inspect pulley grooves for sharp nicks or scratches, repair or replace if damaged.

Order of Tests	Output Voltage	Min. Output Amps	Max Alternator RPM
Test #1	28.0 ± .5	100	8000
Test #2	28.0 ± .5	65	4000
Test #3	28.0 ± .5	10	2500

Table 5.1 - ES- 10024 & ALV-9610 Test Parameters

Order of Tests	Output Voltage	Min. Output Amps	Max Alternator RPM
Test #1	28.0 ± .5	100	8000
Test #2	28.0 ± .5	65	4000
Test #3	28.0 ± .5	10	2500

Table 5.2 - ES- 10024B Test Parameters

Order of Tests	Output Voltage	Min. Output Amps	Max Alternator RPM
Test #1	28.0 ± .5	65	8000
Test #2	28.0 ± .5	54	4000
Test #3	28.0 ± .5	27	2500

Table 5.3 - ES- 6024D Test Parameters

5.4 Alternator Self Excitation Test (-5 & -5LS only)

- A. Self-excitation ability is derived from residual magnetism in the rotor pole pieces, which provides the minimum generated voltage necessary to power the ACU and begin producing power. (This provision only on the ES-10024B-5 or -5LS alternator.)
- B. In order to verify the minimum voltage necessary for self excitation, run the alternator at 5000 RPM with no load (B+) or field connections. Use a digital multimeter (DMM) on the DC Volts scale, to measure the voltage between B+ and case ground. The minimum voltage specified is 2.0 VDC.
- C. If minimum self-excitation voltage is not above the specified voltage above, attempt to restore self-excitation using the following procedure.
 - (1) A voltage regulated DC power supply with the current limit set to 3.5 amp, can be used to “polarize” the rotor by briefly applying 28VDC (nominal).
 - (2) Connect the positive lead of the power supply to the F1 terminal.
 - (3) Connect the negative lead to F2 terminal or the alternator case if the F2 terminal is not present.
 - (4) Ensure the power supply adjustment is set to zero.
 - (5) Turn on the power supply and slowly increase the supply voltage adjustment to 28 VDC.
 - (6) Wait 5 to 10 seconds and slowly decrease the supply voltage adjustment to zero.
- D. The minimum open circuit voltage at 5000 RPM should again be checked. Any unit that fails to polarize per the steps above should be removed from service. Self-excitation applies to ES-10024B-5 or -5LS only. (Do not put an ES-10024B-5 or -5LS into service which does not meet the minimum self-excitation voltage criterion.)

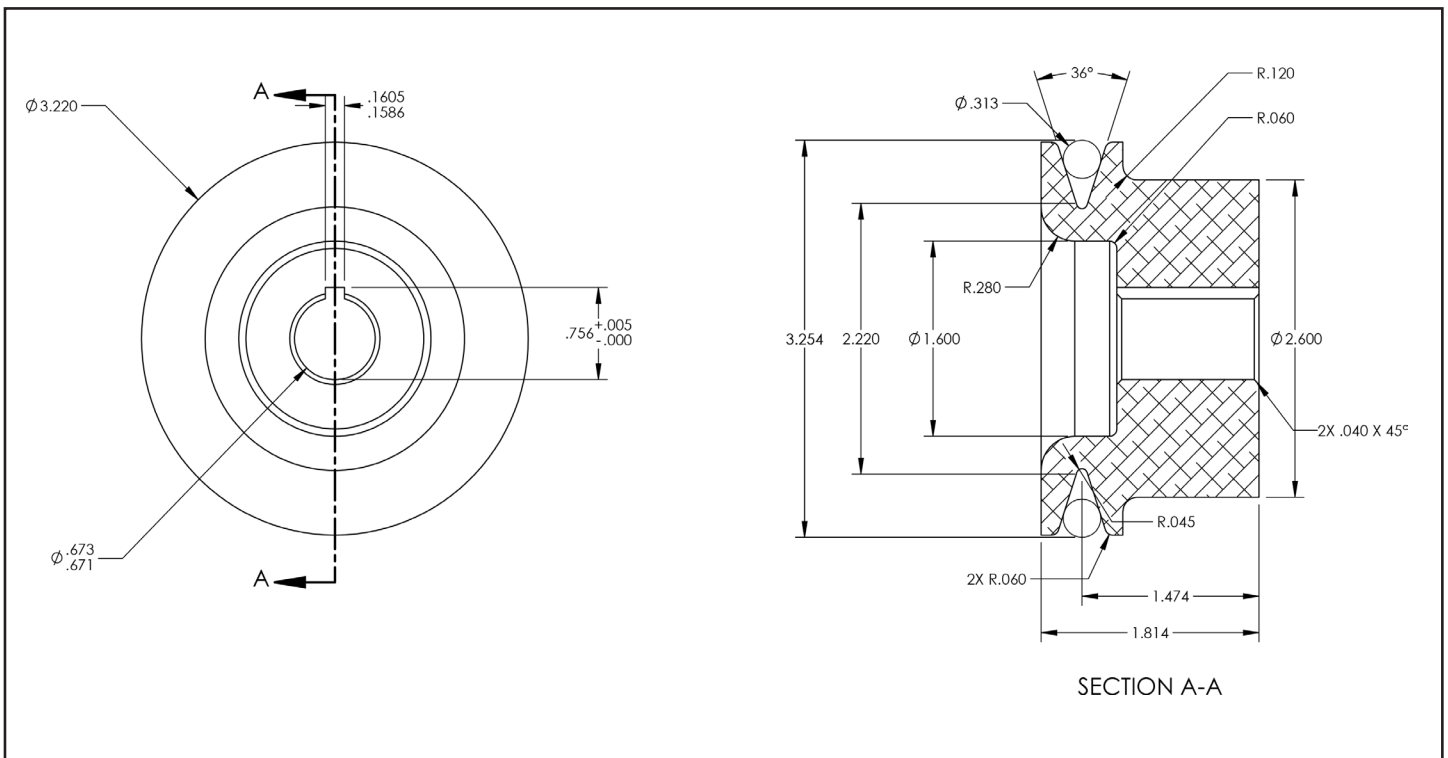


Figure 5.1 - Test Pulley Fabrication Dimensions

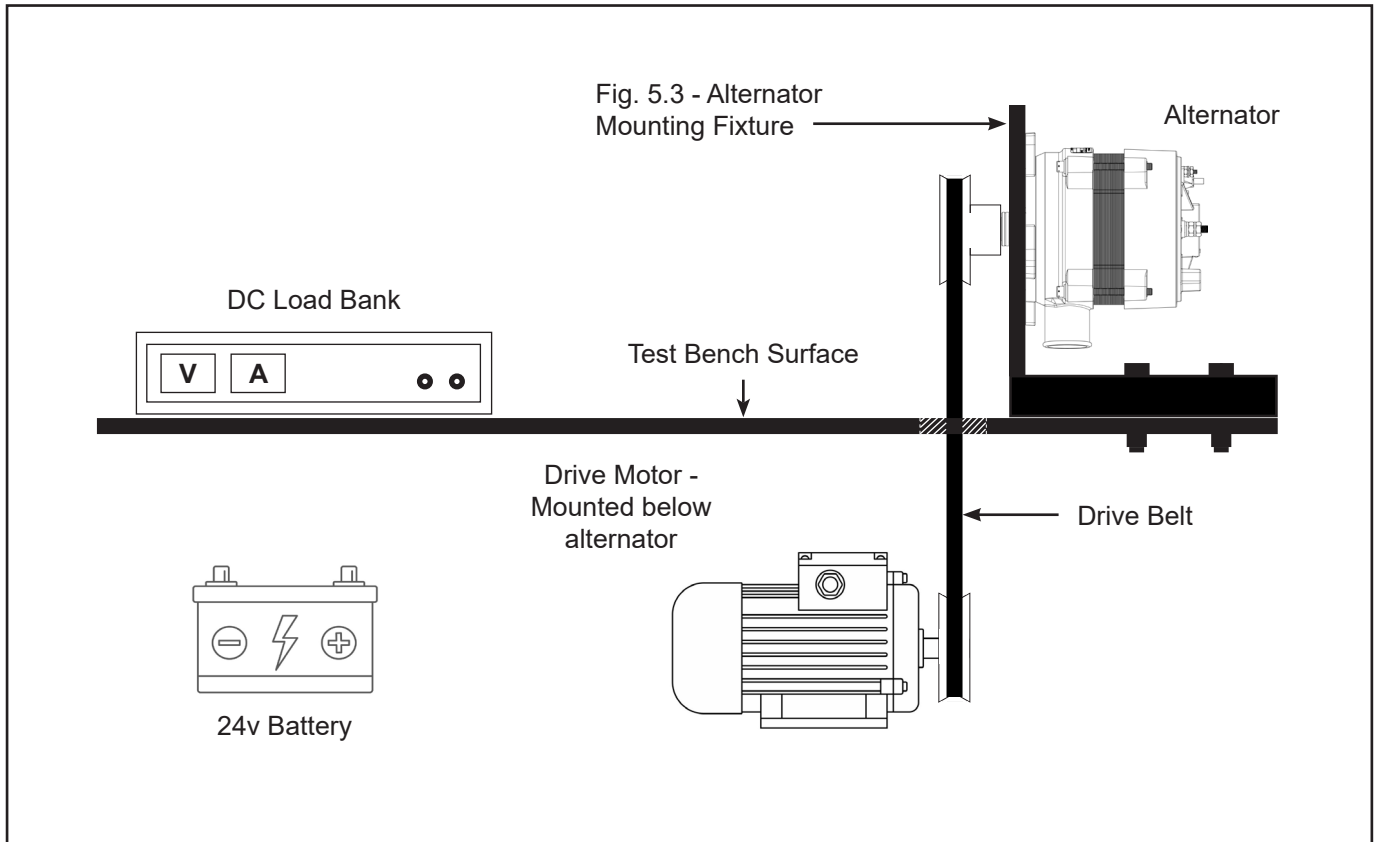


Figure 5.2 - Typical Test Bench Setup

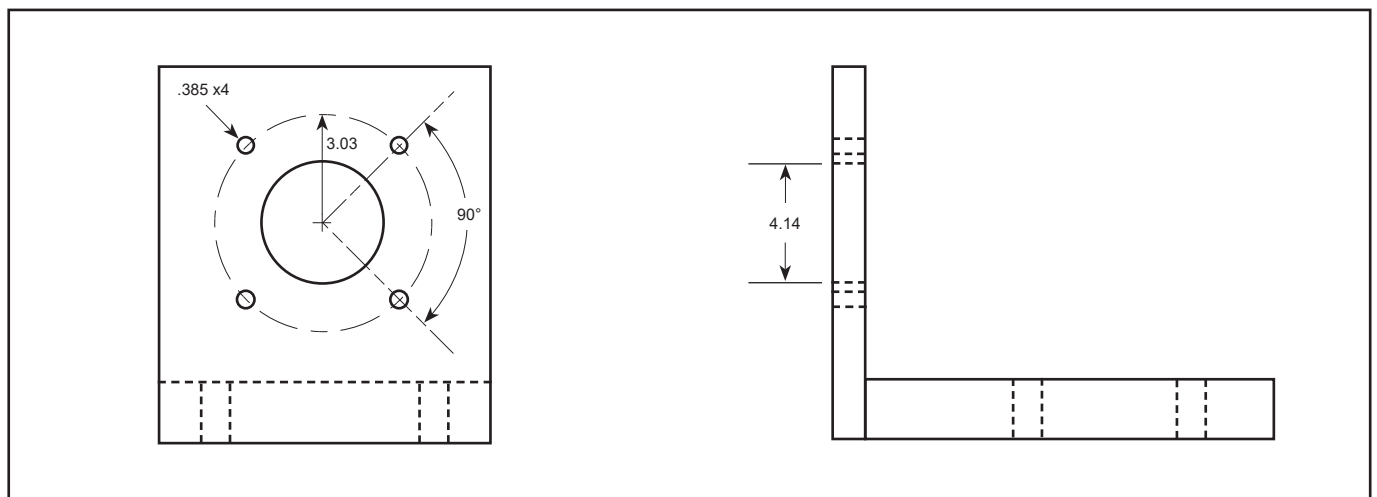


Figure 5.3 - Alternator Mounting Fixture

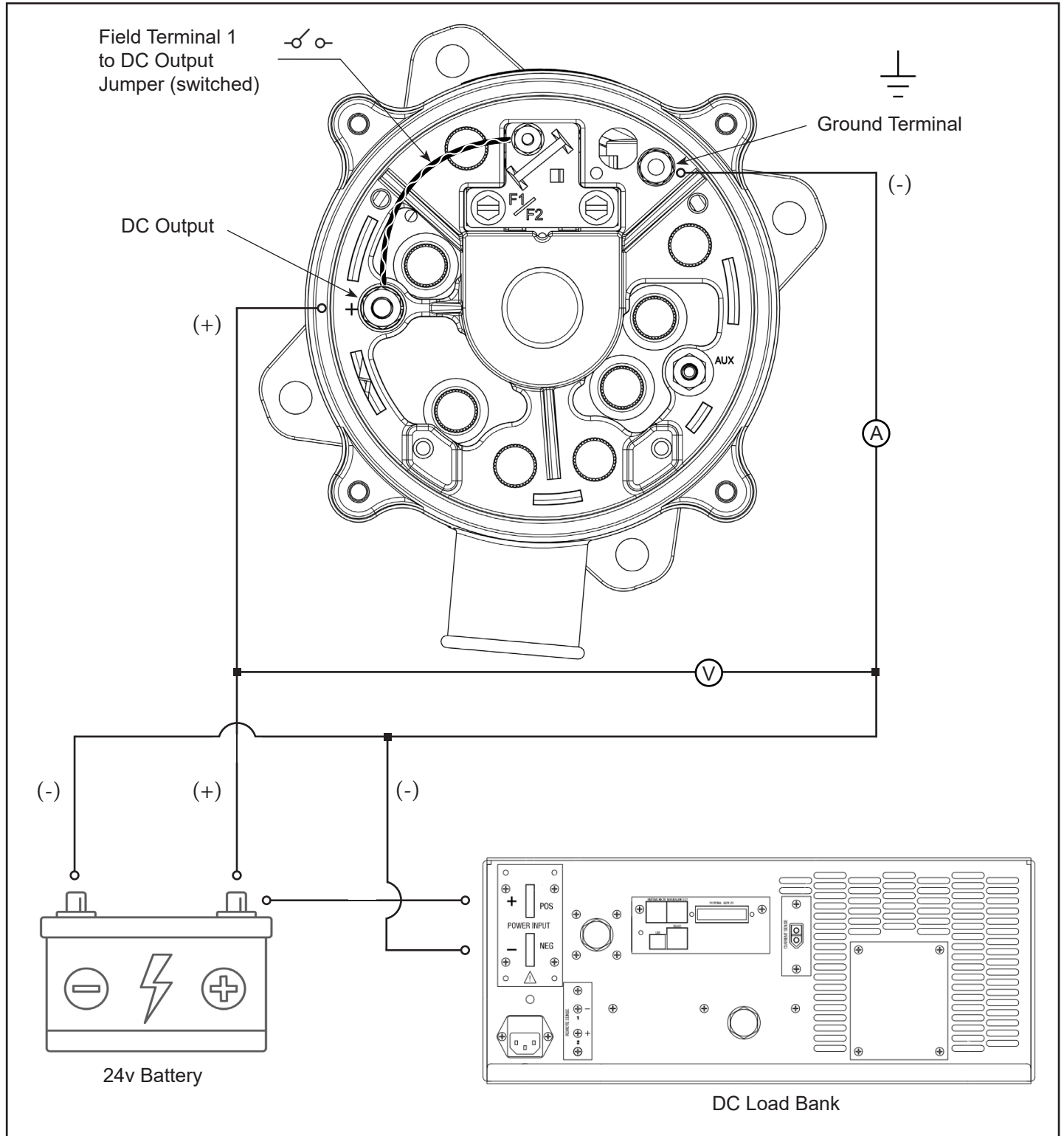


Figure 5.4 - ES-10024 Test Setup

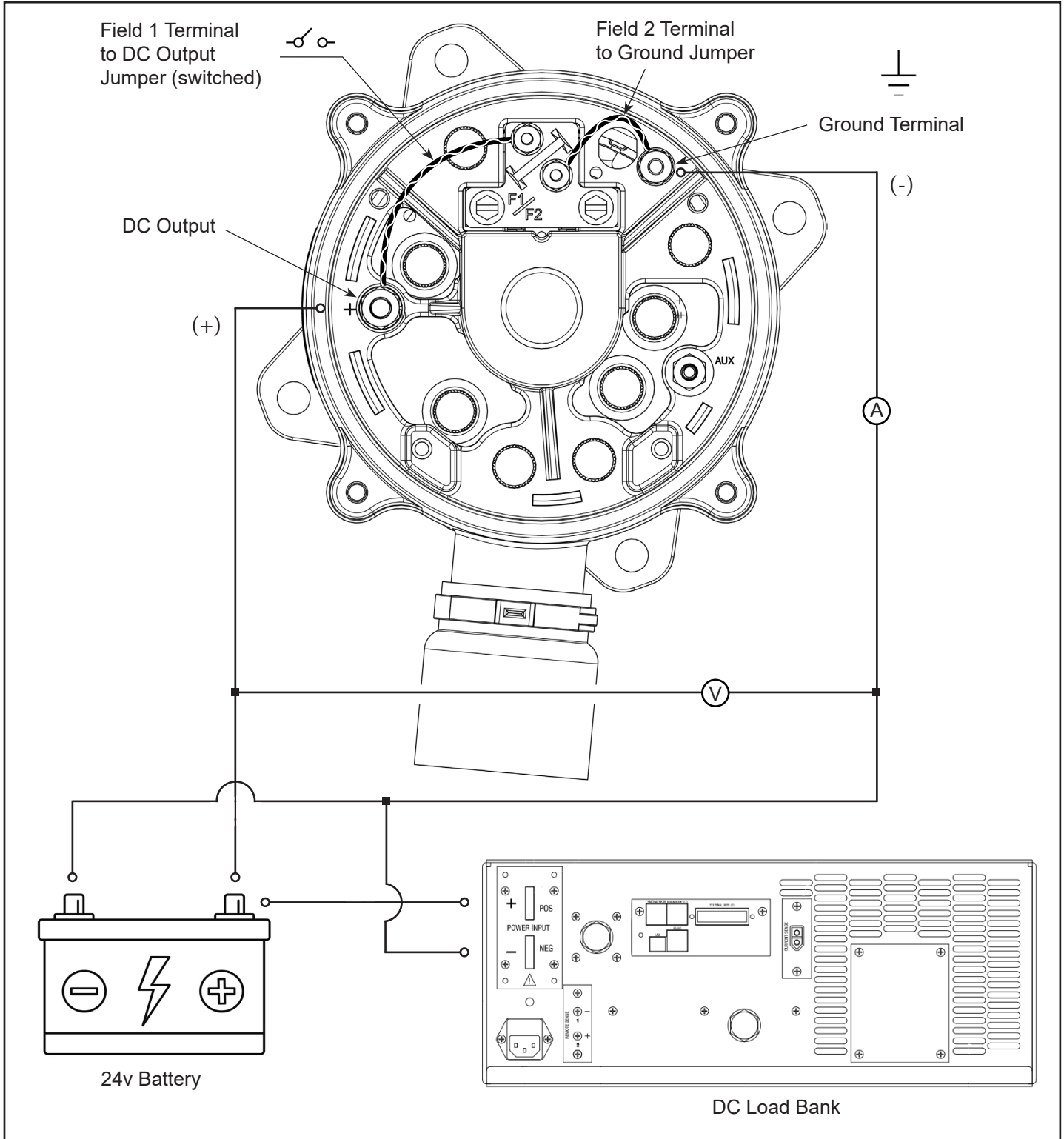


Figure 5.5 - ALV-9610, ES-10024B, and ES-6024D
Test Setup (ALV-9610 Shown)

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CHAPTER 6 - MAINTENANCE

6.1 General

- A. This section contains information regarding recommended maintenance for all alternators listed in this manual. These recommendations assure reliable and safe operation of the alternator while in service. Maintenance is listed in hours time in service (TIS) or calendar time, whichever is applicable but each are the first to occur. Some maintenance is one time initial and others are recurring. Refer to Chapter 4, "Checks" for required inspections.
- A. HET recommended maintenance, checks and TIS may be superseded by the aircraft or engine manufacturers established time limits and schedules based on experience and/or unique requirements under it's Type Certificate or other certifications.

6.2 Bi-Annual Maintenance

- A. The electrical charging system should be inspected at regular intervals, the frequency of which should be determined by the type of service and the conditions under which the aircraft is operated. It is recommended that the following inspection/maintenance be made each six months and should include:

Note:

The FAA requires a battery capacitance check at annual (12 month) intervals. Checks may coincide with each annual inspection. Some battery manufacturers suggest more frequent checks. Refer to the aircraft manufacturers maintenance manual or service information.

- (1) **Battery** - The lead-acid type battery should be checked with a hydrometer to ensure that it is fully charged and filled to the proper level with approved water. Perform a battery capacitance check using an aircraft battery capacitance tester to determine battery condition. Check for dirt and corrosion and clean. If other types of battery are used, follow the specific instructions of the battery manufacturer. (Refer to note above.)
- (2) **Wiring** - The alternator circuit should be inspected to insure that all connections are clean and tight including the battery, field and regulator terminals. The insulators must be sound.
- (3) **Lubrication** - No lubrication is required on the alternator except at the time of overhaul.
- (4) **Drive Coupling** - The drive coupling is a component supplied by the airframe or engine manufacturer. It provides protection to the engine gears and alternator. It should be checked as specified by the engine manufacturer or upon any reduction of alternator output when no cause is apparent. Refer to the engine or airframe manufacturers maintenance manual or service information (as applicable).
- (5) **Drive Belt** - The drive belt is a component supplied by the engine or airframe manufacturer. It should be checked at any maintenance event for condition and replaced as needed or at the engine or airframe manufacturers recommended TIS. Refer to the engine or airframe maintenance manual or service information (as applicable).
- (6) **Operation** - Operate the alternator at a light load (10 amps or less) and note a steady operation with little or no radio noise. If noise exists, the brushes may be worn, the slip rings dirty, a bonding problem, or a failed alternator filter (if so equipped). Operate at max load and observe the output to be at the rated power with little or no radio noise. Loss of power or radio noise may indicate problems with the rectifiers as well as worn brushes or damaged or dirty slip rings.

6.3 Torque Information

Reference	Description	Torque Value (US)	Torque Value (SI)
Figure 6.1 (gear)	Output Shaft Nut	25-37.5 ft-lbs***	33.9-50.8 Nm
Figure 6.2 (belt)	Output Shaft Nut*	55-65 ft-lbs***	74.6-88.1 Nm
Section 2.7	Through Bolts	45-50 in-lbs	5.08-5.65 Nm
Section 2.7 (top & bottom)	Ground Nut (NEG)**	25-30 in-lbs	2.82-3.39 Nm
Section 2.7 (top & bottom)	Output Nut (POS)**	70-85 in-lbs	7.91-9.60 Nm
Figure 6.4	Screws (Brush Holder)	11-14 in-lbs	1.24-1.58 Nm
Section 2.7 (top & bottom)	AUX Nut	25-30 in-lbs	2.82-3.39 Nm
Figure 6.4 (bottom only)	Field Nut (F1 & F2)	12-15 in-lbs	1.36-1.69 Nm
Figure 6.4 (top only)	Field Nut (F1 & F2)	6-8 in-lbs	0.68-0.90 Nm

Table 6.1 - Torque Specifications

* Use a 5/16 inch hex key to hold shaft while applying torque to output shaft nut.

** Attachment of Ground, Battery, Aux. or Field wires from the engine or airframe may use above torque unless value differs from engine/airframe OEM torque. OEM torque specifications shall supersede HET value.
Always hold the bottom nut when applying torque to top nut to prevent over torque of bottom nut.

*** The engine/airframe OEM or the supplier of the drive coupling or belt drive may indicate a torque value for the output shaft that differs from that listed in the Torque Table above. If the torque value differs, the engine/airframe OEM torque value shall supersede the HET value above.

6.4 Alternator Drive Coupling Inspection & Maintenance

(ES-10024, ALV-9610, & ES-6024D)

A. Although the alternator drive coupling is provided by the engine or airframe manufacturer who have issued manuals and/or instructions regarding their maintenance, the coupling is fundamental to the operation of Hartzell Engine Technologies LLC (HET) alternator. As such, some general troubleshooting regarding the coupling is offered here to prevent mis-diagnosis of what may seem to be an alternator fault. Refer to Troubleshooting section 3.

- (1) Check for any and all service information from the engine, airframe and the drive coupling manufacturer concerning the installation, inspection, and replacement of the drive coupling.
- (2) Check the general condition of the drive coupling (requires removal of the alternator).
- (3) Check the shaft nut and cotter pin for damage (damage to these parts will indicate interference with internal engine parts). If damaged, determine cause.
- (4) Using the manufacturer's service information, check the condition of the gear teeth and the elastomer insert. If damaged, replace or overhaul the drive coupling.
- (5) Whenever the alternator is overhauled, HET recommends that the drive coupling be replaced. If the alternator cannot be overhauled or repaired and is being replaced, the coupling should also be replaced.
- (6) To further aid inspection, Continental Motors includes drive coupling service information in the appropriate engine manuals and also in service bulletins. (Refer to the latest CMI SB11-3 and/or SB95-3B for drive coupling service information.)

6.4 Alternator Drive Coupling Inspection & Maintenance (cont'd)

- B. To remove the gear driven alternator from a specific engine, refer to the aircraft and/or engine service and maintenance manuals for detailed instructions.
- C. General Removal - Gear Driven Alternator
 - (1) Make sure external power has been disconnected. Unless otherwise advised, gain access and disconnect the ground (-) cable from the battery post. Isolate and secure the ground (-) terminal.
 - (2) Disconnect the cable from the positive (+) battery post and isolate the terminal.
 - (3) Disconnect the Field wires, AUX wire, output and ground cables from the alternator.
 - (4) Remove the retaining hardware for the alternator and brackets as required. Remove the old engine case gasket and discard. Remove the alternator from the aircraft/engine.
 - (5) If drive coupling is to be removed, cut and remove the cotter pin and use a 5/16 inch hex key to hold the rotor shaft with a 15/16 inch socket or wrench to remove the output shaft nut.
 - (6) Remove the drive coupling from the output shaft if required.

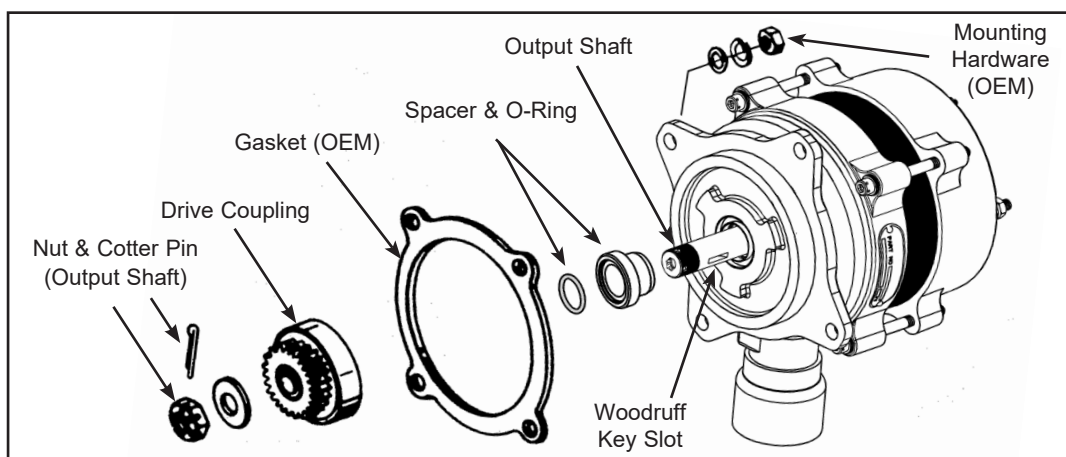


Figure 6.1 - Typical Gear Drive Coupling Arrangement (ALV-9610).

6.5 Alternator Belt & Pulley Inspection & Maintenance

- A. Although the alternator belt is provided by the airframe or engine manufacturer and those manufacturers normally issue manuals or instructions regarding their maintenance, the belt is fundamental to the operation of Hartzell Engine Technologies LLC (HET) alternator. As such, some general troubleshooting regarding the belt is offered here to prevent mis-diagnosis of what may seem to be an alternator fault. Refer to Troubleshooting section 3.3.
- B. To aid in the determination if an alternator is at fault, the following may be used:
- (1) Check for proper belt tension using a tensionometer.
 - (2) Check for belt wear, flat spots, or fraying on edges.
 - (3) Check for belt alignment (may include multiple units driven by one belt).
 - (4) Check for belt contamination (debris imbedded in belt, fluids on belt or pulley).
 - (5) Listen for belt noise, screeching, squealing, chirping, tapping, or grinding.
 - (6) Listen for mechanical noise, grinding from bearing or popping from electrical arcing.
 - (7) Listen or feel for excessive vibrations (loose drive components and tensioners).
 - (8) Whenever belt is replaced, check that installed pulley runout is within tolerance (refer the engine or airframe manufacturer manuals or instructions regarding this maintenance).
- C. Whenever maintenance is required on a belt driven alternator, the external cooling fan must be visually inspected. The following may be used with engine or airframe guidance in the most current revision of the service instructions or maintenance manual:
- (1) Visually inspect the alternator fan for bent and/or missing blades.
 - (2) Visually inspect each blade of the fan in the radius of the blade for cracks as it appears from the edge of the alternator.
 - (3) Visually inspect the fan back plate for cracks appearing from the output shaft area.
 - (4) Spin the alternator pulley and observe the blade and back plate for excessive wobble.
- D. If belt maintenance is required, follow the engine or airframe requirements called out in the most current revision of the service instructions or maintenance manual. The following may be used with engine or airframe guidance:
- (1) Adjust to proper belt tension using a tensionometer. Refer to Table 6.2.
 - (2) Replace belt if worn or damaged in any way.
 - (3) Make proper belt alignment (include all pulleys or devices in drive system).
 - (4) If belt remains undamaged remove contamination from belt surface.
 - (5) Determine cause of belt noise(s) and correct. Refer to Table 6.3.
 - (6) Whenever belt is replaced, check that installed pulley runout is within tolerance (refer to section 5.3.G Inspection & Testing).
 - (7) Determine cause of mechanical noise(s) and correct.
 - (8) Determine cause of excessive vibrations. Tighten drive system brackets and/or replace system components showing wear.
 - (9) If a determination is made that a fault exists in the alternator, overhaul, repair, or replace.

6.5 Alternator Belt & Pulley Inspection & Maintenance (cont'd)

Alternator with Pulley	Maximum Belt Tension
ES-10024B-2	76 lbs / 34.5 kg
ES-10024B-3	80 lbs / 36.3 kg
ES-10024B-4	79 lbs / 35.8 kg
ES-10024B-5	80 lbs / 36.3 kg

Table 6.2 - Alternator Maximum Belt Tension

6.6 Removal from the Aircraft (Belt Drive)

- A. To remove the belt driven alternator from a specific engine, refer to the aircraft and/or engine service and maintenance manuals for detailed instructions.
- B. General Removal - Belt Driven Alternator
 - (1) Make sure any external power has been disconnected. Unless otherwise advised, gain access and disconnect the ground (-) cable from the battery post. Isolate and secure the ground (-) terminal.
 - (2) Disconnect the cable from the positive (+) battery post and isolate the terminal.
 - (3) Disconnect the Field wires, AUX wire, output and ground cables from the alternator.
 - (4) Release the tension from the alternator belt by loosening the retaining bolts. Remove belt from the pulley. Disconnect the retaining hardware and bracketry as required.
 - (5) Remove the alternator from the engine. (Some OEM applications may require the pulley to be removed before the alternator can be removed.) Remove the alternator from the aircraft/engine.
 - (6) Remove the drive pulley from the output shaft if required. Use a 5/16 inch hex key to hold the rotor shaft with a 15/16 inch socket or wrench to remove the output shaft nut. (Early model alternators may require a pulley wrench or similar device to hold the pulley for nut removal.)

Problem	Possible Cause	Corrective Action
Belt Slippage	Lack of tension Overloaded drive Worn pulley or V grooves Oily drive conditions	Increase tension Reduce load or check pulley size Replace pulley Clean drive, resolve oil leak
Belt turn over	Misaligned drive Worn pulley or V grooves Heavy Impulse loads Excessive vibration Broken cords cause by prying belt over pulley Wrong pulley or belt	Realign shafts and pulleys Replace pulley Check idler pulley (spring or not) Check tension Tension v-belt, if tension is good, inspect belt condition or replace Replace Belts, do not pry belt over pulley Check to see if belt rides high or if belt bottoms out in groove
Rapid belt wear	Worn pulley grooves Pulleys misaligned Mismatched belts (Multi belts only) Belt slippage Pulley diameter too small Overloaded Drive	Replace pulley Align pulleys and brackets Replace mismatched belts Increase tension Check P/N and/or replace pulley Pulley size on components correct
Belt Separated	Foreign materials in drive belt Belt slippage (over time) Heavy start-up loads Belts damaged during installation	Check that pulley is protected Increase tension or replace belt Reduce load before starting Install new belts properly
Belt stretch	Excessive drive tension Broken cords using multiple belts Large Misalignment	Use proper tension Replace belts with matched set Realign brackets and pulleys
Belt squeal	Belt slippage Insufficient arc of contact Overloaded drive	Increase tension Increase center distance Pulley size on components correct
Belt chirp	Misaligned drive Belt tilted in pulley groove Belt riding on side of pulley groove	Align the pulleys and brackets Correct angle of belt Adjust bracket in or out of seat belt
Belt bottom cracks	High surrounding temperature Pulley diameter too small Belt slippage	Provide ventilation Redesign drive Increase tension
Overheated bearings	Continuous belt slippage Excessive drive tension Bearings not lubed or are damaged	Increase tension Tension drive properly Replace bearings

Table 6.3 - Alternator Maintenance (Belt)

6.7 Exterior Cleaning (direct drive or belt drive)

NOTE:

Prior to cleaning the alternator whether mounted on the aircraft or as removed, observe and note condition. Look for any arcing, wear marks, fretting or other indicators of defect.

CAUTION:



DO NOT SPRAY CLEANING FLUIDS INTO THE ALTERNATOR HOUSING OPENINGS. SOLVENTS MAY HAVE A HARMFUL EFFECT ON BRUSHES AND SLIP RINGS. OPENINGS SHOULD BE TEMPORARILY PLUGGED WITH SHOP TOWELS.

- A. If mounted on an aircraft to engine, initial cleaning may be done using mineral spirits or isopropyl alcohol under pressure. Blow dry using clean shop air.
- B. If removed, initial cleaning should be done using a shop cloth and mineral spirits or isopropyl alcohol. Wipe dry using clean shop cloths.

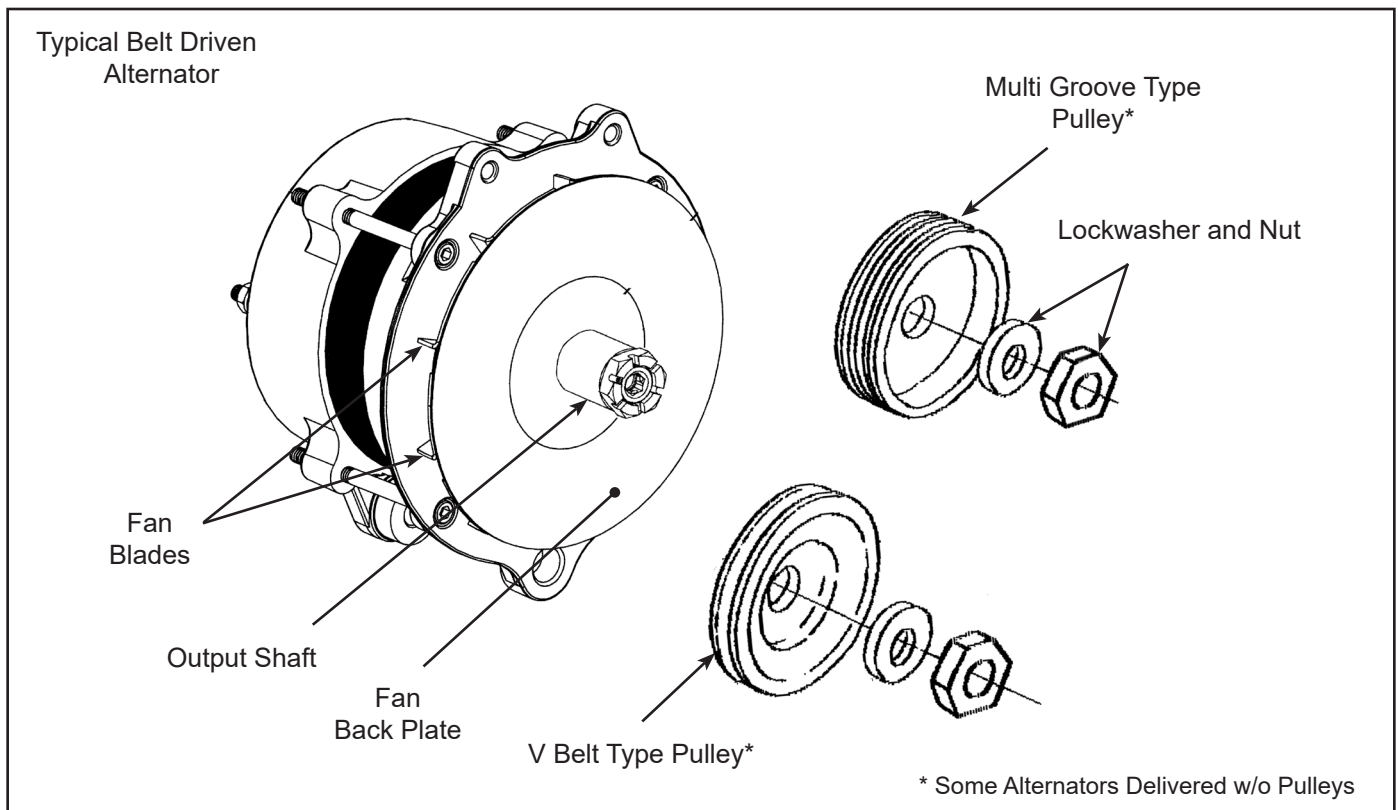


Figure 6.2 - Belt Drive with Pulley (ES-10024B-1 thru -5, -5LS)

6.8 Brush Removal and Installation

NOTE: Brushes must be replaced in pairs. If replacing brushes only, order two (2) each, HET P/N ALE-13A brushes through an authorized HET distributor. HET recommends replacing the brush holder ass'y HET P/N ALU-3045BS or ALE-3045BS as applicable. These include new brushes pre-installed. Refer to Materials section 6.11.

A. Removal:

- (1) Make sure aircraft battery and external power source has been disconnected.
- (2) If necessary for access to the brush holder screws, remove the clamp from the air duct attached to the alternator blast tube and disconnect the air duct.
- (3) Disconnect the two top terminal nuts for F1/F2 while holding the bottom nut. Temporarily insulate the terminals to prevent possible sparking. Refer to Figure 6.4a. Please note, some alternator models may have an internal grounding path for the field and will not have an F2 terminal.
- (4) Remove the two screws that hold the brush holder ass'y in the slip ring end housing (SRE). Refer to Figure 6.3a.
- (5) Slowly remove the brush holder ass'y from the SRE taking care not to drop the brushes into the alternator (brushes are spring loaded). If checking brushes only, be sure to mark and note the position and orientation of each brush. Discard the brushes if replacing.
- (6) If both brushes are not present upon removal of the brush holder, the missing brush must be located and recovered from the alternator before proceeding.

B. Installation:

Prepare to install brush holder into the alternator.

- (1) Install a new set of brushes, HET P/N ALE-13A into the brush holder. Place each new brush into the brush holder. Brushes must be oriented such that the axis of the curvature of the brush face is parallel with axis of F1/F2 terminals. Refer to Fig. 6.3c. If checking brushes only, be sure to place in the same position and orientation as removed.
- (2) Install a two inch stiff 22 gage insulated wire into the hole provided in the side of the brush holder while pushing in each brush with a soft tool like a small wood or nylon dowel. The wire will retain the brushes for installation of the holder. Refer to Fig. 6.3d.
- (3) Install the brush holder ass'y with the insulated brush retaining wire in place. Install the two brush holder screws. Refer to Fig. 6.3b.
- (4) Torque the brush holder screws to 11-14 in-lbs (14.91 to 18.99 Nm). Refer to Fig. 6.3a.
- (5) Spin the shaft several rotations to check for interference between the brush holder and rotor.
- (6) Remove insulated brush retaining wire from brush holder ass'y. Rotate shaft in running direction and listen for smooth operation. Refer to Figure 6.3d.
- (7) Torque first nut, F1 & F2 as required, to 12 -15 in-lbs. Connect field terminals from aircraft harness. Install terminal washers and nuts. Torque second nut to 6 -8 in-lbs.
- (8) Restore aircraft battery and/or other power source which has been disconnected.

6.9 Through Bolts

The alternator through bolts are designed to retain proper torque for the life of the alternator. Occasionally over time, vibration may loosen the through bolts. This may be noticed by broken or loose safety wire or cable and may appear as a blackened area at the through bolt head or threads. If loose, the following procedures apply:

- A. Inspect the through bolts while installed, they must not be bent, cracked, or damaged.
- B. If any through bolt is bent, cracked, damaged or housings are loose, the alternator should be replaced or overhauled. (Loose and damaged through bolts may indicate serious internal damage in the alternator.)
- C. If the through bolt(s) are not damaged in any manner but appear only to be loose, it is permissible to apply proper torque. This may be accomplished by removing the alternator or in the aircraft as space permits.
- D. Cut the safety wire or safety cable from the bolt head at the drive end of the alternator and discard. Using a calibrated torque wrench, apply 40-45 in-lbs (5.08-5.65 Nm) torque to the loose through bolt. After application of torque, check and apply the proper torque to the remaining through bolts. Refer to Table 6.1 for proper torque.
- E. Install new .032 stainless steel safety wire or safety cable (HET P/N RX-1961) through the drilled hole in the through bolt head at the drive end of the alternator. Refer to section 6.14 or 6.15.

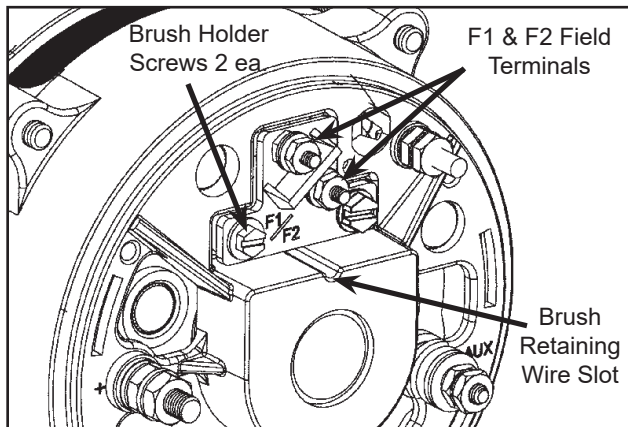


Figure 6.3a - Brush Holder Locations

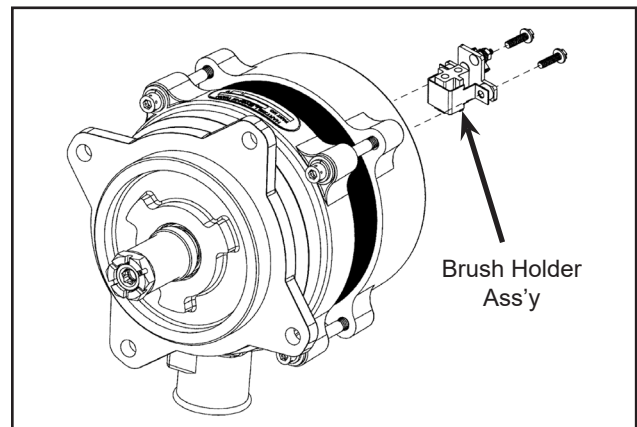


Figure 6.3b - Brush Holder Installation

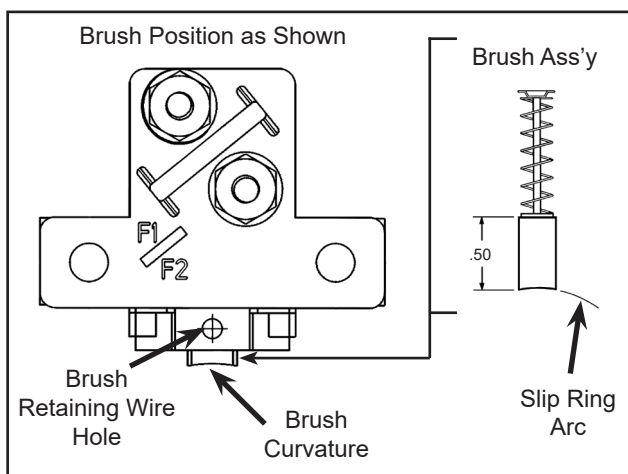


Figure 6.3c - Brush Position in Holder

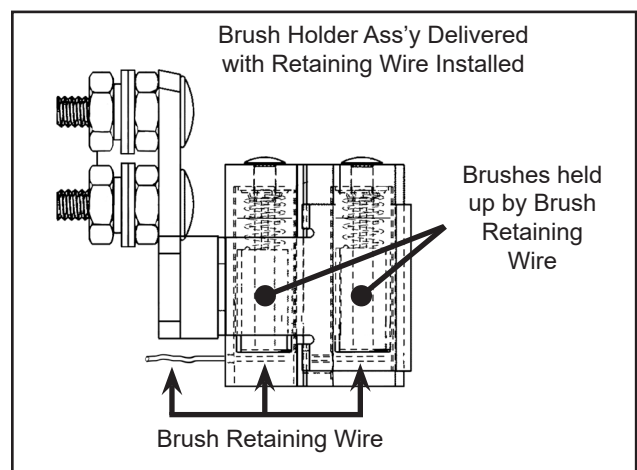


Figure 6.3d - Brush Retaining Wire

6.10 Terminal Hardware Removal and Installation

A. Removal

- (1) AUX Terminal: Using a thin 3/8 wrench, hold the bottom nut and loosen the top nut as shown in Figure 6.4 AUX Terminal. This is required to prevent the loss of the factory torque of the bottom nut. Remove and discard lockwasher. Nuts are HET P/N 8X-0173 & lockwasher is HET P/N 12X-0196.
- (2) Output Terminal: Using a thin 7/16 in. wrench, hold the bottom nut and loosen the top nut as shown in Figure 6.4 AUX Terminal. This is required to prevent the loss of factory torque of the bottom nut. Remove & discard lockwasher. Output nuts are HET P/N 8X-1063. Lockwashers are HET P/N 12X-0199.
- (3) Ground Terminal: Using a thin 3/8 in. wrench, hold the bottom cupped nut and loosen the top cupped nut shown in Fig. 6.4 Ground Terminal. This is required to prevent the loss of factory torque of bottom nut. Ground nuts are HET P/N 40298.
- (4) Field Terminal(s): Using a thin 5/16 in. wrench, hold the bottom nut and loosen the top nut as shown in Fig. 6.4 Field Terminal(s). This is required to prevent the loss of the factory torque of the bottom nut. Remove and discard lockwasher. Field nuts are HET P/N 8X-0140. Lockwashers are HET P/N 12X-0194.

B. Installation

- (1) AUX Terminal: Check bottom nut for a torque of 25 to 30 in-lbs (2.82-3.39 Nm). Place a new lockwasher, HET P/N 12X-0196 and the existing AUX nut, HET P/N 8X-0173 on the AUX stud. Using a thin 3/8 inch wrench, hold the bottom nut and tighten the top nut to a torque of 25 to 30 in-lbs (2.82-3.39 Nm). Refer to Figure 6.4 AUX terminal.
- (2) Output Terminal: Check bottom nut for a torque of 70 to 85 in-lbs (7.91-9.60 Nm). Place new lockwasher, HET P/N 12X-0199 and the existing Output nut, HET P/N 8X-1063 on the Output stud. Using a thin 7/16 (.4375) wrench, hold the bottom nut and tighten the top nut to a torque of 70 to 85 in-lbs (7.91-9.60 Nm). Refer to Figure 6.4 Output terminal.
- (3) Ground Terminal: Check bottom nut for a torque of 25 to 30 in-lbs (2.82-3.39 Nm). Place existing Ground cupped nut, HET P/N 40298 on the Ground stud. Using a thin 3/8 inch wrench, hold the bottom cupped nut and tighten the top cupped nut to a torque of 25 to 30 in-lbs (2.82-3.39 Nm). Refer to Figure 6.4, Ground Terminal.
- (4) Field Terminal(s): Check bottom nut for a torque of 12 to 15 in-lbs (1.36-1.69 Nm). Place new lockwasher, HET P/N 12X-0194 and the existing Field nut, HET P/N 8X-0140 on the Field stud. Using a thin 5/16 in. wrench, hold the bottom nut and tighten the top nut to a torque of 6 to 8 in-lbs (0.68-0.90 Nm). Refer to Figure 6.4, Field Terminal.

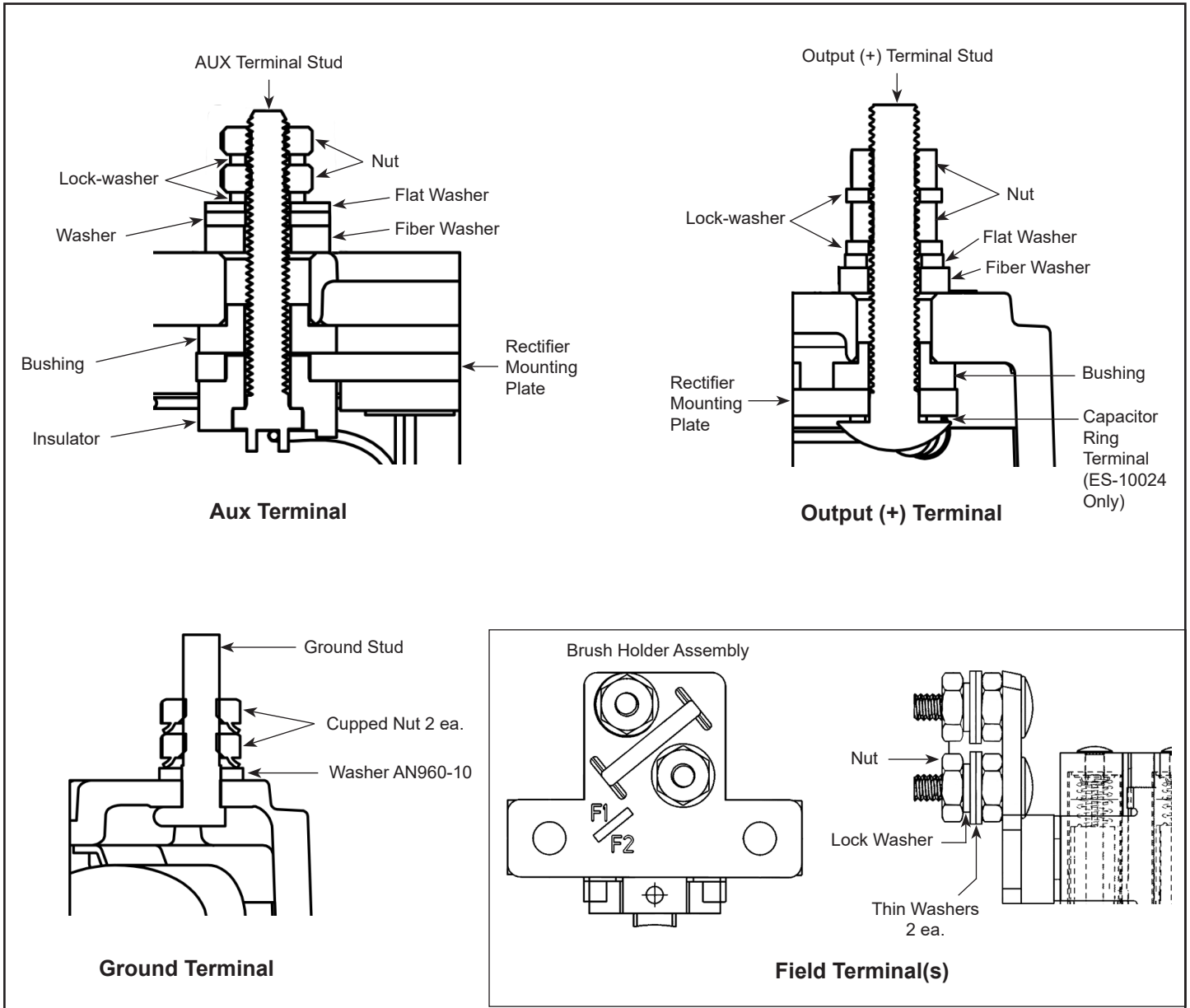


Figure 6.4 - AUX, Output, & Ground Terminal Stud Assembly

6.11 Materials

This section presents the current materials available for maintenance. Items are available through an HET authorized distributor and are the only parts available at this time. Some parts such as OEM pulleys alternator belt, and drive coupling may only be available from aircraft/engine OEM.

A. Hardware

- (1) One (1) each, Nut, Output Shaft, HET P/N GBM-21B. Replace when removed. (ES-10024B only)
- (2) One (1) each, Washer, Locking, (Output Shaft) HET P/N 40523-4. Replace when removed. (ES-10024B only)
- (3) One (1) each, Nut, Output Shaft, HET P/N 8X-4075. Replace when removed. (gear driven only)
- (4) As required, Nut, AUX terminal, HET P/N 8X-0173.
- (5) As required, Lockwasher, AUX terminal, HET P/N 12X-0196. Replace when removed.
- (6) As required, Nut, Output terminal, HET P/N 8X-1063.
- (7) As required, Lockwasher, Output terminal, HET P/N 12X-0199. Replace when removed.
- (8) As required, Cupped Nut, Ground terminal, HET P/N 40298.
- (9) As required, Nut, Field terminal, HET P/N 8X-0140.
- (10) (10) As required, Lockwasher, Field terminal, HET P/N 12X-0194. Replace when removed.

B. Specific Items

- (1) One (1) each, Pulley, 10 Groove, HET P/N 40840. (ES-10024B-5)
- (2) One (1) each, Pulley, 6 Groove, HET P/N 40485. (ES-10024B-4)
- (3) One (1) each, Pulley, 6 Groove, HET P/N 40483. (ES-10024B-3)
- (4) One (1) each, Pulley, V Groove, HET P/N 40482. (ES-10024B-2)

C. Special Items

- (1) One (1) each, "O" Ring, HET P/N 32B70247A01. Replace when removed. (N/A ES-10024B)
- (2) One (1) each, Woodruff Key, (Output Shaft) HET P/N X-3832 for ES-10024B only, X-0260 for direct drive ES-10024, ES-6024D, ALV-9610. Replace when removed.
- (3) One (1) each, Spacer, (Output Shaft) HET P/N ALD-0021. (ES-10024B only)
- (4) One (1) each, Spacer, (Output Shaft) HET P/N 41151.
- (5) One (1) each, Plate, Fan, HET P/N PU-0604A. (ES-10024B only)
- (6) One (1) each, Fan, Bi-Directional, HET P/N PU-605A. (ES-10024B only)
- (7) Two (2) each, Brush Ass'y, HET P/N ALE-13A.
- (8) As required, Screw, Brush Holder HET P/N 03C44209B15.
- (9) One (1) each, Brush Holder Ass'y, HET P/N ALU-3045BS for ES-10024B & ALV-9610 (optional)
(Includes holder, brushes, & brush retaining wire.)
- (10) One (1) each, Brush Holder Ass'y, HET P/N ALE-3045BS for ES-6024D & ES-10024. (optional)
- (11) As required, Safe-T-Cable™, HET P/N RX-1961. (or .032 stainless steel safety wire.)

6.12 Applying Safety Wire

- A. If applying safety wire, use .032 stainless steel per the standards outlined in AC43.13.1b or NASM-33540 of the latest revision. (Safety wire does not maintain fastener torque.)

6.13 Applying Safety Cable

- A. If applying an HET P/N RX-1961 Safe-T-Cable™, follow the recommended procedures of the Safe-T-Cable™, manufacturer. Applicable detailed procedures may be found on the Safe-T-Cable™, website: <http://www.dmctools.com>.
 - (1) Use of the Safe-T-Cable™ requires the use of special tool kit DMC-1000-4R Tools and Parts Kit for .032" Safe-T-Cable™.

6.14 Installation on the Aircraft (Gear Drive)

- A. To install the alternator on the engine, refer to the applicable engine and/or aircraft service and maintenance manuals. Always follow the OEM instructions.
- B. General Installation
 - (1) Make sure the aircraft battery and any external power has been disconnected.
 - (2) Install the alternator drive coupling with new thrust washer, following Continental Motors, Inc. drive coupling service information in the applicable engine maintenance manual and service bulletins. (Refer to the latest revision of CMI SB11-3 for drive coupling service information.)
 - (3) Install a new engine case gasket on the clean crankcase surface per the applicable Continental Motors, Inc. engine manual. Obtain applicable part number gasket from CMI.
 - (4) Position the alternator and install the retaining hardware and brackets as required. Torque the crankcase mounting bolts to the torque specification found in the appropriate Continental Motors engine manual.
 - (5) Connect the Field wires, Aux wire, the output and ground cables on the proper terminals of the alternator. Refer to section 2 and Figures 2.4b, 2.5b, or 2.7b for locations.
 - (6) Unless otherwise advised by the OEM, connect the positive battery cable to the positive (POS) battery terminal, then connect the aircraft ground cable to the negative (NEG) battery terminal.
 - (7) Check the alternator for security and make a running performance test per the AFM or POH and the engine/ aircraft service and maintenance manuals.

6.15 Installation on the Aircraft (Belt Drive)

- A. To install the alternator on the engine, refer to the applicable engine/aircraft maintenance manuals and service instructions. Some OEM require the pulley to be removed prior to the installation of the alternator. Always follow the OEM instructions.
- B. General Installation
 - (1) Make sure the aircraft battery and any external power has been disconnected.
 - (2) Position the alternator and install the retaining hardware and brackets as required.
 - (3) Connect the Field wires, Aux wire, the output and ground cables on the proper terminals of the alternator. Refer to Chapter 2 and Figure 2.2 for locations.

- (4) Re-connect the blast air tube if required.
- (5) If pulley is to be installed, torque pulley nut 55 to 65 ft-lbs (74.6 Nm to 88.1 Nm) and check pulley run out per section 5.2.G. (Use pulley wrench to hold pulley, later units use 5/16 inch hex key to hold shaft while applying torque to output shaft nut.)

CAUTION:



DO NOT EXCEED TENSION LIMITS. EXCESSIVE BELT TENSION CAN LEAD TO PREMATURE WEAR AND BEARING FAILURE.

- (6) Install the alternator belt and properly tension in accordance with the most current revision of the engine/ aircraft maintenance manuals and service instructions. If a max tension value is not provided by the OEM, use applicable values found in table 6.2. A tensionometer should be used to set the specified belt tension.
- (7) Unless otherwise advised by the OEM, connect the positive battery cable to the positive (POS) battery terminal, then connect the aircraft ground cable to the negative (NEG) battery terminal.
- (8) Check the alternator for security and make a running performance test per the AFM or POH and the engine/ aircraft service and maintenance manuals.

6.16 Special Conditions:

NOTE: For engine OEM's Special Condition "Sudden Stoppage", refer to the latest revision of Lycoming Engines, Inc. SB 533B or Continental Motors, Inc. SB96-11B.

A. Sudden Engine Stoppage (gear drive):

- (1) If the engine has experienced "sudden stoppage" as defined by the engine manufacturer, the alternator may be impacted critically by this event. Although the alternator drive system is designed with an OEM supplied elastomer drive coupling which protects the engine from seizure of the rotating components inside the alternator, the coupling may place unknown strain on the alternator shaft from the sudden stoppage of the engine drive train. The shaft may be weakened, cracked, or have unseen damage from this event, setting up for a future failure under normal operating conditions if not thoroughly inspected.
- (2) If "sudden stoppage" as defined by the engine manufacturer has occurred, the gear driven alternator must be repaired, overhauled, or replaced. Refer to the appropriate engine or airframe manuals to remove the alternator. **Item 3 must be performed on any sudden stoppage by a qualified repair or overhaul shops.**
- (3) If the alternator has been involved in an accident with sudden stoppage and the alternator is to be overhauled in lieu of replacement, it is required that a qualified technician perform a magnetic particle inspection (ASTM E 1444) to check the condition of the rotor shaft.

B. Sudden Engine Stoppage (belt drive)

- (1) If the aircraft engine has experienced a "sudden stoppage" as defined by the engine manufacturer, the alternator may be impacted critically by this event. Although a belt driven alternator is protected somewhat by the ability of the belt to slip or come off the pulley, the sudden stoppage may cause the seizure of the rotating components inside the alternator. The sudden stop may bend the pulley, damage the bearings, or shift close tolerance parts inside the alternator allowing contact when rotating.

- (2) If “sudden stoppage” as defined by the engine manufacturer has occurred or if a sudden stoppage has caused the belt to twist or come off, the alternator must be inspected. Refer to the appropriate engine or airframe manuals to remove the alternator. Check the following:
 - (a) Belt - remove belt - check for flat spots, cuts, or broken fabric.
 - (b) Pulley - check for damage such as bending or scarring. Check for pulley groove for damage. Make a run out check on the face of the pulley to check for alteration of the pulley due to bending. **Refer to section 5.3(G) for checking pulley run out.** Check appropriate engine or airframe manuals for run out spec's as many pulleys ARE NOT supplied by HET.
 - (c) Alternator Fan - with belt removed, spin the pulley to check for alternator external fan or back plate wobble. Refer to section 6.4(B) for inspection of the external fan.
 - (d) Alternator - with belt removed, snap spin the pulley to check for interference between the rotor and stator and to check for bearing noise. Refer to section 5.2(B) for checking the bearings.
 - (e) Pulley Nut - check for fractures and assure proper torque at the completion of these procedures.
 - (f) Brushes - remove brush holder and brushes to check for broken or chipped brush, and other damage. Refer to section 5.2(F) for brush holder and brush checks.
 - (g) If you find damage in step (2), b through e, repair, overhaul, or replace the alternator. In addition, all supporting bracketry or mounts associated with the alternator should be inspected in accordance with the appropriate engine or airframe manuals. Assure all steps are taken to properly return the aircraft to service.

C. Lightning Strike

NOTE:

For engine OEM's Special Condition “Lightning Strike”, refer to the latest revision of Lycoming Engines, Inc. SB 401 or Continental Motors, Inc. SB 88-9.

- (1) Lightning strike is a very unpredictable event both in occurrence and in resultant damage. A lightning bolt entry point may have many exit points or only one. On a well bonded aluminum aircraft, the lightning bolt will stay on the outer surface throughout the aircraft with little damage to components. The path of the electrical current cannot easily be determined in most cases because while the current may surge through well bonded areas without damage, a gap in any metal contact point will result in an arc or flash burn. This is especially true of rotating parts such as gears or shaft.
- (2) If a report of a potential or actual lightning strike is made the first thing to do is to inspect the aircraft for entry and exit points for the lightning bolt. The purpose is to assure that there was indeed a strike. The points of entry or exit are generally on the aircraft extremities such as the wing tip, propeller tips, spinner tip or the tips of tail surfaces. Commonly, the entry point is a single burn mark and the exit several burn marks or burnt static wicks. This discussion is important because if there was a strike it may have coursed through the engine. Cowlings, especially fiberglass or other non-metallic types may not have as good a bond. Many cowlings will not be well bonded due to frequent removal. This many times will force the electric charge to take a route through the engine components. Lightning will arc at any gap where the path of resistance is less that the surrounding air.

- (3) If a strike has occurred, (especially if arc burns appear on the propeller) remove the alternator and inspect for arc marks. If gear driven, observe the drive coupling teeth as an arc here may leave raised metal which will also cause further damage when running. If belt driven, the most likely damage will occur within the alternator or its attachments or mounting brackets. Observe the mounting points and bracketry for arc marks at joints and attachments. Use the appropriate engine and/or aircraft, manufacturers maintenance manuals or service instructions to accomplish this task.
- (4) If evidence of a strike is observed and the alternator is being overhauled or replaced due to this evidence or due to malfunction, it is advised that the entire aircraft/rotorcraft electrical system be inspected. Use the appropriate engine and/or aircraft/rotorcraft manufacturers maintenance manuals or service instructions to accomplish this task.
- (5) If there is no indication of arcing or other damage and a lightning strike cannot be confirmed, reinstall the alternator and check per the applicable airframe and engine manufacturers maintenance or service instructions.
- (6) Upon completion, test run the engine per the POH or AFM prior to returning the aircraft to service. Make an appropriate logbook entry concerning the lightning strike.

6.17 Storage and Shelf Life:

A. Storage

When storing a new, overhauled or repaired alternator, there are several categories to consider. Short term storage or long term storage on or off the aircraft. Short term storage will be considered as storage up to but not exceeding twenty-four (24) calendar months. Long term storage will be considered as storage up to but not exceeding twelve (12) calendar years. There are different methods for each type of storage.

- (1) Short term, if on the shelf, requires only that the unit be kept inside in the original packaging. If unit is on the aircraft (or unmounted engine) no additional action other than that required for the engine or aircraft is needed.
- (2) Long term, if on the shelf, requires that the alternator be removed from the box and from the plastic bag as originally packaged. Discard the bag. Wipe or lightly spray outside and all openings with electrically friendly preservative oil. Wrap tightly with a waxed type paper (new bags may be used if specifically formulated for the storage of metal products). Place back into original shipping container and store in a cool dry environment.
- (3) If it is anticipated or determined that the aircraft (or unmounted engine) will be in a long term storage situation, as soon as practicable, lightly spray outside and all openings with electrically friendly preservative oil. No additional action other than that required for the engine or aircraft is needed.
- (4) At the expiration of twelve (12) calendar years from date of manufacture or overhaul, regardless of storage or usage, the unit must be overhauled.

B. Shelf Life

- (1) All alternators (HET, Kelly, ESI, Prestolite or others now manufactured by HET) have a shelf life of up to, but not to exceed, twelve (12) calendar years at which time the unit must be overhauled. *Shelf life time applies only if storage requirements are observed.*