

AIRCRAFT ALTERNATOR MAINTENANCE MANUAL

P/N PP2013

ALTERNATOR MODELS:

AL24-P70-3

AL24-P70-4

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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@Hartzell.aero

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 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
NEW	5/13/2025	ALL	Approved via PCO-112649

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 THESE LIMITATIONS ARE THE MINIMUM REQUIRED TO MEET CONTINUED AIRWORTHINESS BUT MAY BE SUPERSEDED BY MORE STRINGENT REQUIREMENTS AS PUBLISHED BY THE FAA, AIRCRAFT, ROTORCRAFT OR OTHER MANUFACTURERS THAT USE THESE COMPONENTS IN THEIR APPLICATIONS.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 approved 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 alternator. 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 Limitations associated with this equipment and/or installation.

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 Tech 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 Tech 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 Tech LLC alternators.

No liability will be assumed by Hartzell Engine Tech 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 Tech 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 this manual are U.S. units with International System of Units (SI) in parentheses.
- B. The AL24-P70-3 and AL24-P70-4 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. This 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. This 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 necessary sections. Refer to the check section to determine required periodic actions and maintenance sections for alternator service.
- 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	Pound-force
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)

AFM	Aircraft Flight Manual
ALT	Alternator
ATA	Air Transport Association of America
DE	Drive End (housing)
DIA	Diameter
FAA	Federal Aviation Administration (USA)
FIG.	Figure
GAMA	General Aviation Manufacturers Association
ID	Inside Diameter
HET	Hartzell Engine Tech 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)

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).

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.

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

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.

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

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

1.8 Disposal

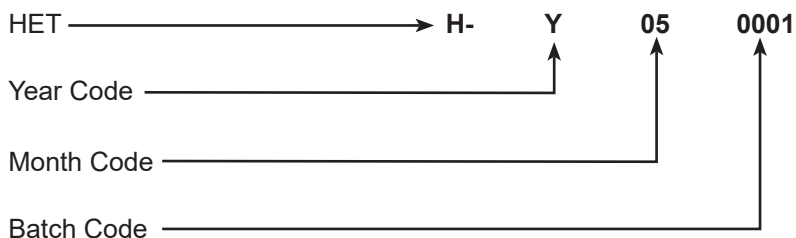
- A. Rectifiers and PCB components may be considered hazardous waste and should be discarded whole through your local hazardous waste management system.

1.9 Model Identification

AL24-P70-3 - 24V, 3/8" Pulley

AL24-P70-4 - 24V, 3/8" Pulley

1.10 Serial number Identification



Example above: 2024, 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 Tech LLC (HET) offers a Limited warranty with each new, overhauled, or rebuilt Alternator assembly or component (parts) it sells through it's 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 affect 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 2.4B below.

B. Operational Data: All Models

Belt Driven:	Belt Tension - 50-90 lbs.
Air Cooled:	-
Rotation:	Bi-directional - Optimal performance when clock-wise viewed from the drive end
Max Continuous operating speed:	10,000 RPM
24V Operating Speed: AL24-P70-3, -4:	3,000 RPM MIN
24V Operating Output (Rated): AL24-P70-3, -4:	28.4 volts, 70 amps
Weight:	9.5 lbs

C. Dimensions

- (1) The basic alternator dimensions are shown in Fig. 2.2A and 2.3B.

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 Fig. 2.1 which shows the basic electrical operating points and connections.

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 pin in the field connector housing of the brush assembly. The brush holder assembly is mounted 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 six 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. One end of each coil is electrically connected to the bridge rectifier network. The other end of each coil is connected to the other end of two of the separate coils.
- D. The auxiliary terminal is electrically isolated from but mechanically mounted to the rectifier heat sink and SRE housing. It is electrically connected to one end of one stator winding and provides an electrical voltage signal that varies 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 diodes are installed in a crescent-shaped aluminum heat sink. The mechanical connection between the diode 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 diodes are installed in a crescent-shaped aluminum heat sink mechanically connected to the SRE housing. The mechanical connection between the diode 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. The brush holder and terminal assembly contains an electrical filter to minimize EMI and RFI noise. The filter is a conventional thin film capacitor.

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. 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.

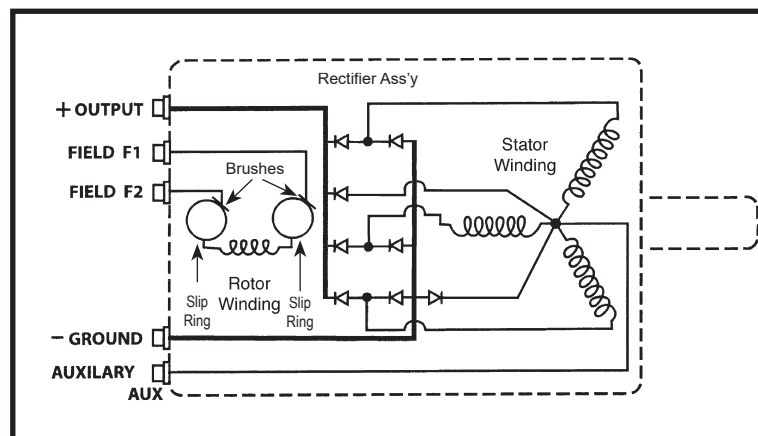
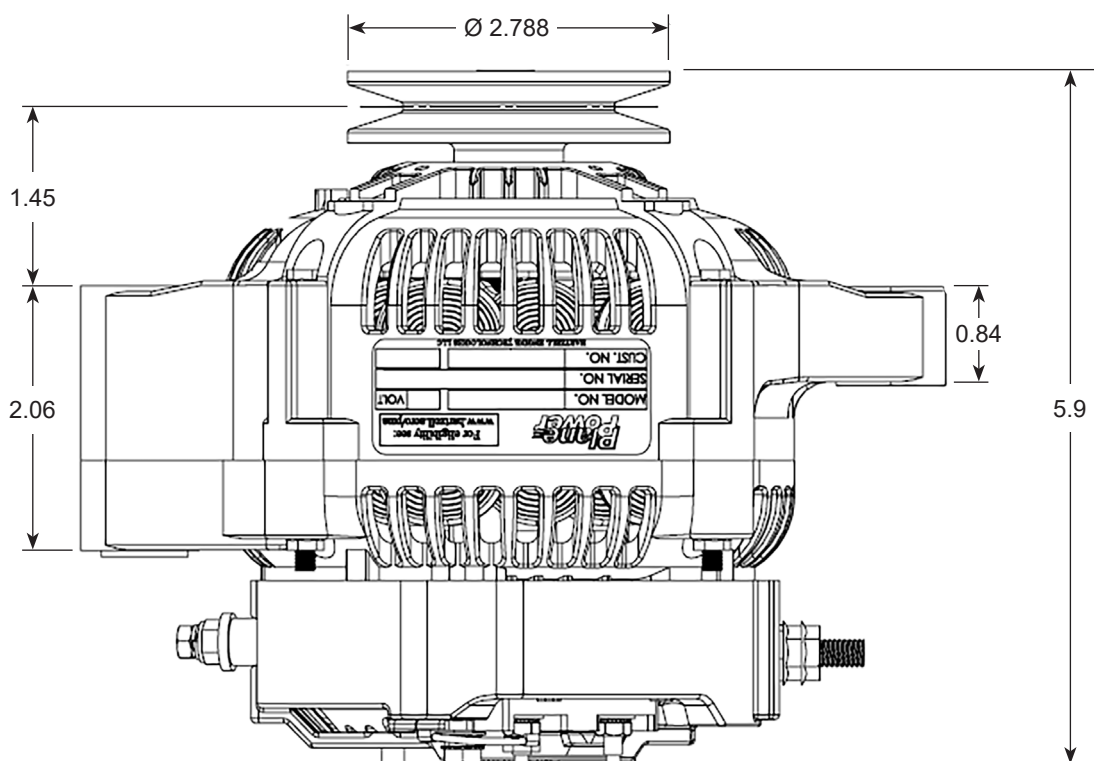
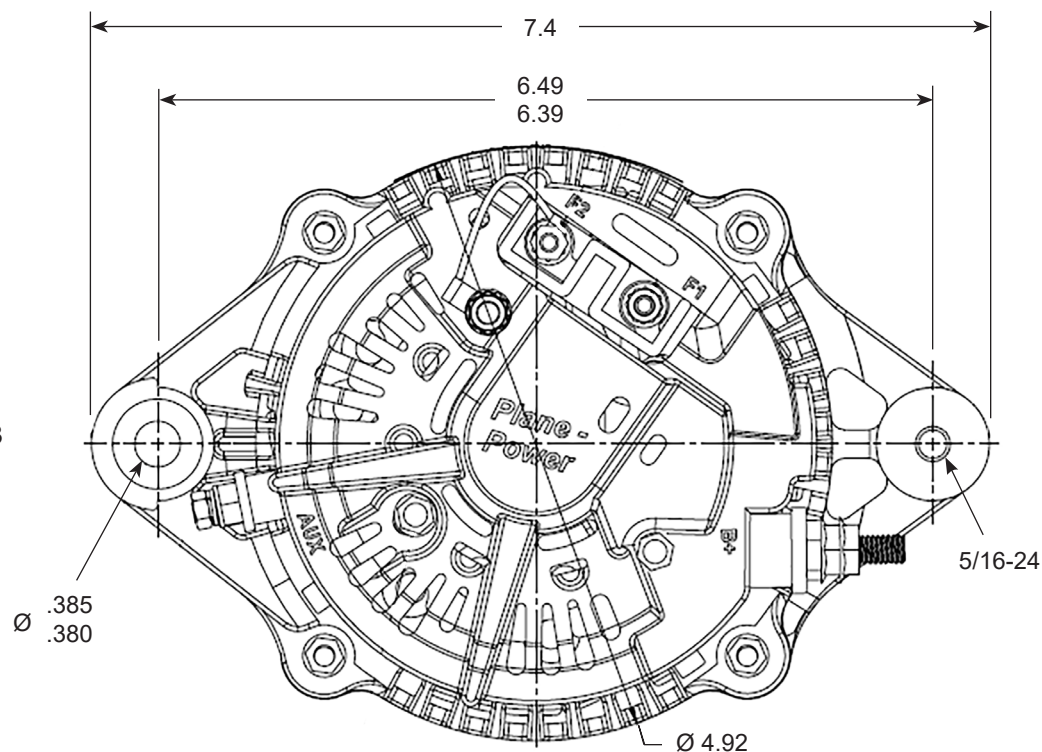


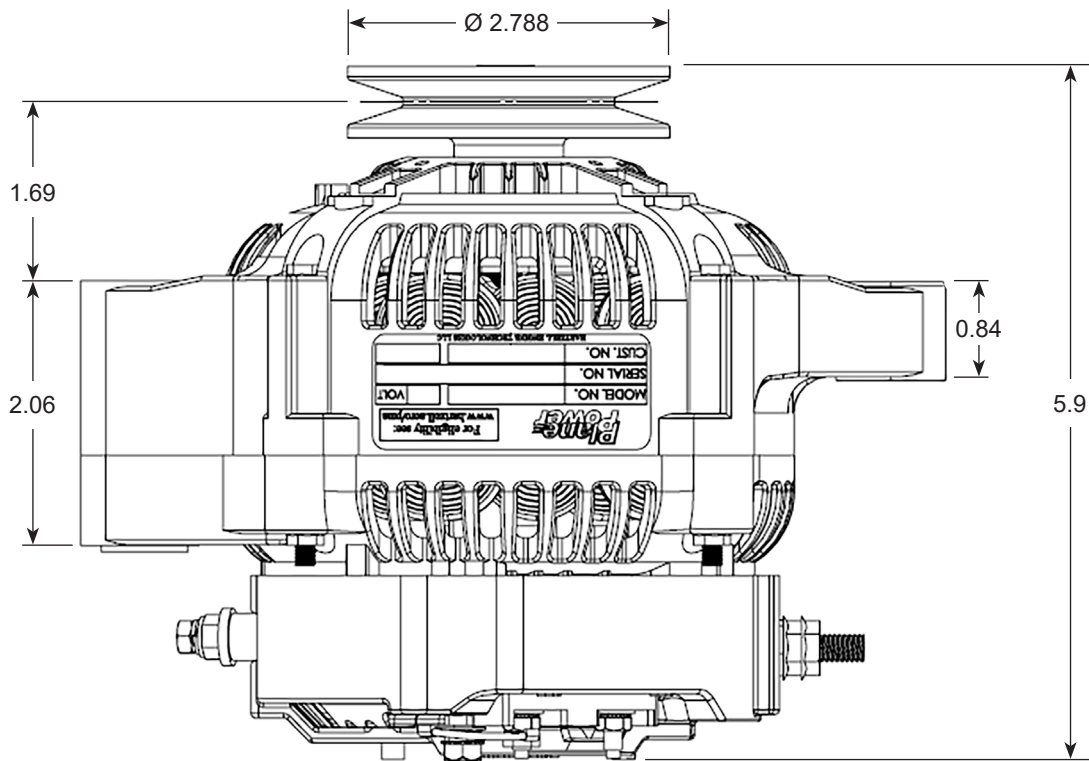
Figure 2.1 - Basic Electrical Diagram



**Figure 2.2A - AL24-P70-3
Dimensions, Typical**

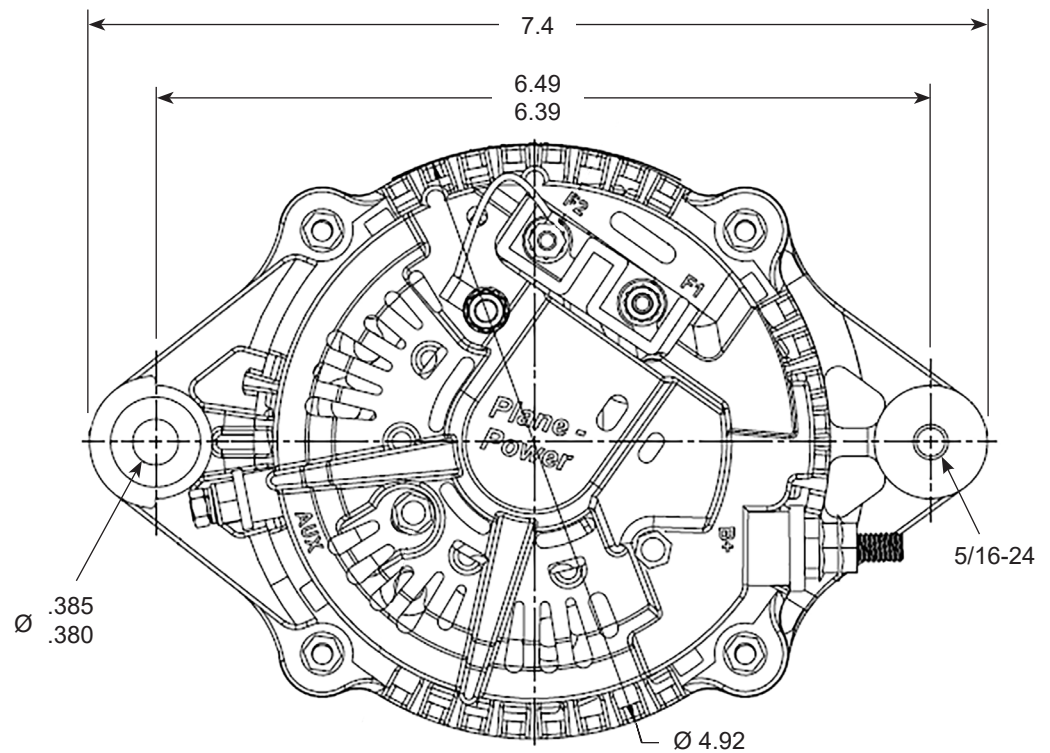
**Figure 2.2B - AL24-P70-3
Dimensions, Typical**





**Figure 2.3A - AL24-P70-4
Dimensions, Typical**

**Figure 2.3B - AL24-P70-4
Dimensions, Typical**



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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 (Chapter 5) for applicable test procedure(s).

3.2 Procedure

WARNING



WHEN SERVICING OR REPAIRING 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 following identify primary areas of potential alternator issues and suggested remedies.

Loose terminal connections: 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 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. See Chapter 6.

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.

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.

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 alternator.

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 mounting bolts: Inspect mount points for damage and if found, replace 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.

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

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.

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.

Insufficient output filtering: Remove brush holder and inspect brush holder capacitor for damage and capacitance.

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 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 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 grooves 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 picking up alternator, A/C compressor, hydraulic pump, or idler pulleys. Belt drives are efficient and safe; however, the more complex the configuration, 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.
- 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 use their own custom pulley and belt arrangements. The HET alternator designated as delivered without a pulley may have an “LS” suffix. Other HET series alternators are delivered with varied size and type pulleys and are designated with a unique dash number suffix.
- 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 and the alternator must be replaced. Acoustic 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 still 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.
- J. Whenever the pilot witnesses 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

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

- (1) Check the alternator to engine mounting bolts for proper torque per aircraft, rotorcraft and/or engine service instructions or maintenance manual.
- (2) Inspect area around the brush holder for soot. If a large amount of soot appears, remove brush holder and check for wear or damaged brushes.
- (3) If wear has occurred, check slip rings for gouges or scratches.
- (4) Check electrical terminal hardware for tightness and insulators for condition.

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

- (1) Remove brush holder and check each brush for wear or damage. If brush shows more than 50% wear or has chips or damage, replace the brush holder assembly and brushes (brushes are included in new brush holder assembly). New brushes are 0.50 inch (12.7 mm) long.
- (2) With the alternator removed, inspect belt and belt drive line components. Adjust belt tension to proper values per engine/aircraft service instructions or maintenance manual.
- (3) Inspect the aluminum housings for surface corrosion, clean as necessary.
- (4) Inspect the housings for cracks around the through bolt holes and ears. Replace the alternator if necessary.

C. TBO concurrent with engine TBO

- (1) Replace alternator at engine TBO.

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CHAPTER 5 - INSPECTION AND TESTING

5.1 General

- A. 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 Section prior to applying any test for maintenance.
- B. Where applicable, components called out this section will correspond to the item number listed in MAINTENANCE Section 6.

5.2 Testing

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

Standard and special tools used in this chapter are limited.

- Voltmeter (0 to 30 VDC)
- Ammeter, 0 to 100 Amp
- Carbon Pile (or equivalent)
- Belt tension gauge, universal
- Alternator test bench (24V, 0 - 100A). (if removed to test)

(3) Instruments

- A multimeter, (Simpson 260 or Fluke 87) or equivalent (accuracy 1%).
- Optical tachometer.

B. Test conditions

- (1) Ambient temperature: 70 to 80 ° F (21 to 27 ° C).

C. 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 GROUND THE OUTPUT TERMINAL.** Grounding of the alternator output terminal may damage the alternator and/or aircraft electrical circuit.
- (4) **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.
- (5) **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.

5.3 Testing & 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) 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.
- (5) 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 must 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 must be replaced.

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 Field terminal (orange insulator) and the other lead to ground terminal.
- (2) Spin the output shaft and note ohmmeter reading. Meter should read between 5.8 and 20 ohms.
- (3) A reading lower than the above range indicates either a grounded field terminal or a failed rotor. Replace alternator.
- (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 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 of the alternator.

5.4 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:

The preferred method of testing the alternator is by use of a commercially available alternator test bench (rated 24 volt, 0 - 100 A), however the procedures below are also considered adequate for testing purposes.

- (1) The alternator is to be at room temperature 70-80 degrees Fahrenheit (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 thirty (30) seconds for each test point.

B. Test Set Up:

- (1) Fabricate the test set up as shown in Figure 5.1.
 - (a) This consists of a battery (24 volt DC, 150 ah min. or 12 volt DC, 40 ah min), common carbon pile, test voltmeter (0-28 VDC), test ammeter (0-100 amp), and an appropriate length of jumper wire.
- (2) Apply 50-70 lbs. of tension to the drive belt and check for belt slippage. If the belt slips, increase tension in 5 pound increments, not to exceed 90 lbs. Check drive belt tension with a belt tension gauge.
- (3) Use an Optical tachometer to observe RPM (per manufacturers instruction).
- (4) Battery (-NEG) and the alternator case must share a common ground.

C. Ventilation:

WARNING:

ALTERNATORS REQUIRE A SOURCE OF VENTILATION. DO NOT TEST ALTERNATORS IN AN ENCLOSED SPACE AT FULLY RATED OUTPUT FOR MORE THAN 30 SECONDS UNLESS A COOLING AIR SOURCE IS SUPPLIED. FAILURE TO VENTILATE MAY CAUSE CATASTROPHIC ALTERNATOR AND EQUIPMENT DAMAGE WHICH MAY RESULT IN INJURY OR DEATH.

CAUTION:

OPERATING AN ALTERNATOR WITH THE FIELD (F1) TERMINAL CONNECTED TO THE B+ TERMINAL CAN RESULT

IN VERY HIGH VOLTAGE OUTPUT (>100 VDC) WHICH MAY DAMAGE THE ALTERNATOR AND TEST EQUIPMENT.

NOTE:

Begin testing with the carbon pile adjusted to maximum electrical load which equates to minimum resistance.

D. Test Procedures:

- (1) Adjust the carbon pile, as necessary to obtain the specified voltage shown in Table 5.1 (CW) or Table 5.2 (CCW).

CAUTION:

EXCEEDING THE BATTERY VOLTAGE RATING MAY DAMAGE THE BATTERY OR CAUSE AN EXPLOSION. THIS MAY RESULT IN INJURY, BURNS, AND/OR EQUIPMENT DAMAGE.

- (2) Apply power while observing the voltmeter, observe RPM using the optical tachometer and the output amps on the ammeter.
- (3) Vary the RPM while maintaining the specified voltage. Observe the amperage at each RPM. At each

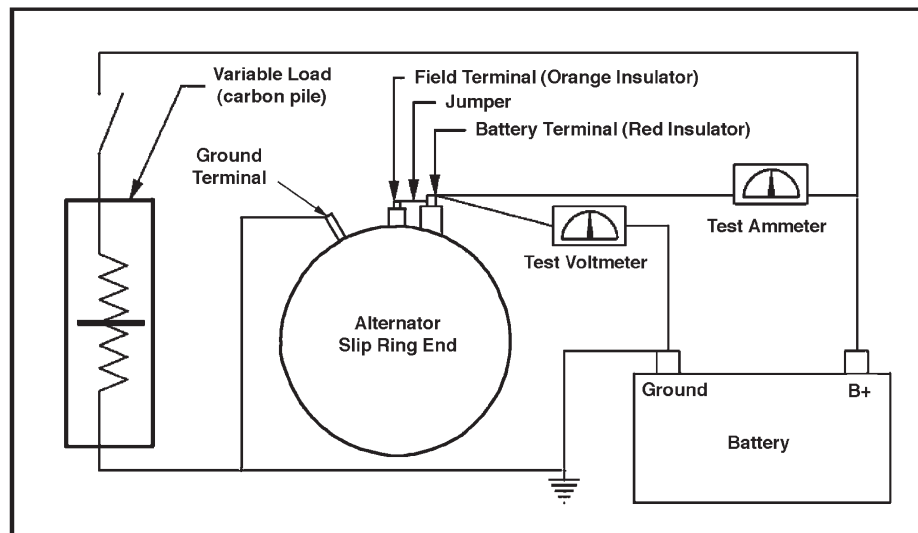


Figure 5.1 - Typical Bench Testing Set Up.

RPM, the Min. Output Amps must be achieved as specified in Table 5.1 (CW) or Table 5.2 (CCW).

Min. Output Voltage	Min. Output Amps	Alternator RPM
23.7 ± .2 Vdc	2	2000 ± 50
25.8 ± .2 Vdc	58	5000 ± 50
25.8 ± .2 Vdc	71	8000 ± 50
25.8 ± .2 Vdc	75	10000 ± 50

Table 5.1 - Alternator Models: ALT24-P70-3, -4 (CW Rotation)

Min. Output Voltage	Min. Output Amps	Alternator RPM
24.3 ± .2 Vdc	2	2000 ± 50
25.8 ± .2 Vdc	54.1	5000 ± 50
25.8 ± .2 Vdc	64.3	8000 ± 50
25.8 ± .2 Vdc	68.6	10000 ± 50

Table 5.2 - Alternator Models: ALT24-P70-3, -4 (CCW Rotation)

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.
- B. 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 Brush Holder Assembly Removal and Installation

NOTE: Refer to Table 6-1 for new brush holder assembly. Brush holder assembly includes pre-installed new brushes. Refer to Figures 6.1 and 6.2 for the following:

- A. Removal:
 - (1) Make sure aircraft battery and external power source has been disconnected.
 - (2) To remove the alternator from the engine, refer to the applicable engine and/or aircraft service and maintenance manuals.
 - (3) Remove the three M5 nuts (1).
 - (4) Remove the M4 nut (2) with flat and lock-washer, discard lock-washer (2a).
 - (5) Remove the ground strap (5).
 - (6) Remove the M6 nut (3) securing the case insulator (4).
 - (7) Remove the case insulator (4).
 - (8) Remove the Aux. terminal (6) with flat and lock-washer, discard lock washer (6a).
 - (9) Remove the SREcover.
 - (10) Remove the brush cover (7).
 - (11) Remove the three M4 screws (8) securing the brush holder assembly (9).
 - (12) Remove the brush holder assembly (9) and discard.

B. Installation:

- (1) Install a new brush holder assembly (9) by holding down the brushes with index finger and sliding the brush assembly over the rotor shaft.
- (2) Install three M4 screws (8) to secure the brush holder assembly. Torque the M4 screws (8) 16-20 lbf · in (1.81-2.26 N · m).
- (3) Install the brush cover (7).
- (4) Install the SRE cover. Do not install M5 nuts (1) at this time.
- (5) Install the ground strap (5) and M4 nut (2) with flat washer and new lock-washer (2a), torque nut (2) 16-20 lbf · in (1.81-2.26 N · m).
- (6) Install and torque the three M5 nuts (1) to 35 lbf · in (3.95 N · m).
- (7) Install the Aux. terminal (6) with flat washer and new lock-washer (6a)
- (8) Install the ground terminal stud (3) and torque to 35 lbf · in (3.95 N · m).
- (9) Install the case insulator (4) and M6 nut (3). Torque nut (3) to 50 lbf · in (5.65 N · m)

6.3 Installation of Alternator on Engine

- A. To install the alternator onto the engine, refer to the applicable engine and/or aircraft service and maintenance manuals.

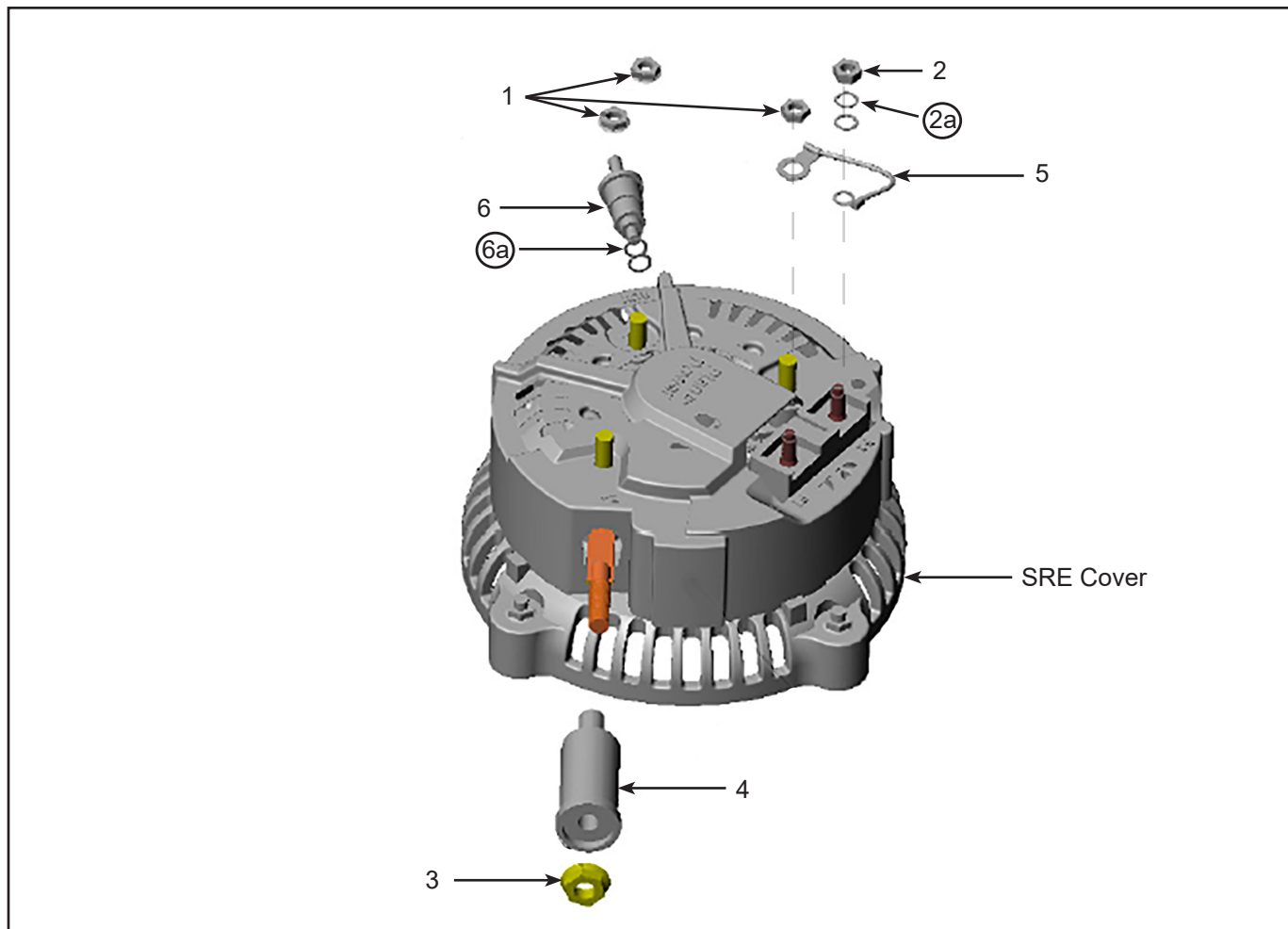


Figure 6.1 - Brush Holder Replacement

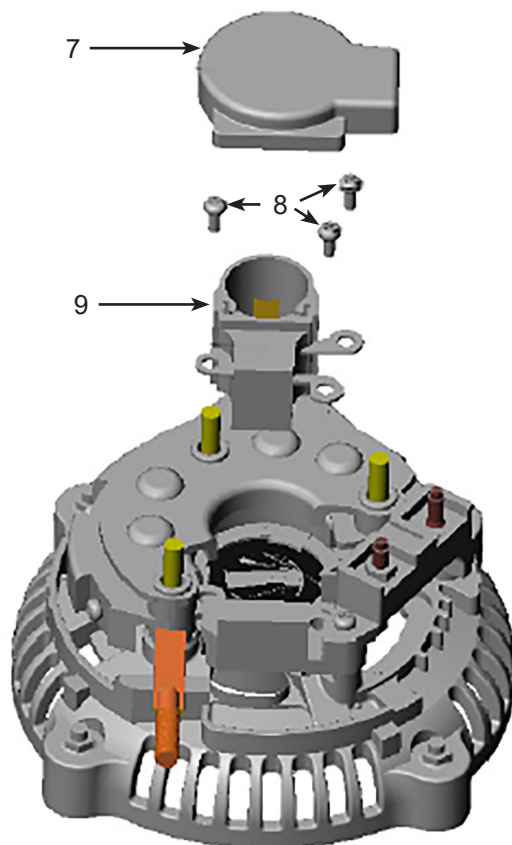


Figure 6.2 - Brush Holder Assembly Removal

Table 6.1 - List of Materials

6.4 Special Conditions:

A. Lightning Strike

- (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. 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 it's 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 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.

6.5 Storage and Shelf Life:

A. Storage

When storing a new 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, regardless of storage or usage, the unit must be replaced.

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 replaced. *Shelf life time applies only if storage requirements are observed.*

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